FOREWORD

by

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(President of the Institution).

THE lectures and discussions on the recruitment and training of engineering craftsmen here published constitute a very useful contribution to the consideration of a subject of prime importance to the engineering industry. Two main conclusions emerge. One is that the whole problem needs much greater attention than it has yet received. The other is that our Institution can, if it applies itself to the task, take the lead in securing that the problem receives the attention it deserves.

On a matter of this kind—not to mention numerous other issues—it would seem highly desirable to establish, for purposes of consultation, some avenue of approach to representative engineering firms likely to be in full sympathy with the general aims of the Institution.

In article 15 of our constitution, provision is made for affiliating firms to the Institution, and it would seem that here, ready to our hand, is the best avenue of approach we could possibly devise.

Already we have a nucleus of affiliated firms, and if the number were sufficiently extended we could, within our own ranks, build the necessary machinery for consultative purposes. Given a good lead in the case of firms to which our members are attached, we can then look with some degree of confidence to other firms for similar support.

December, 1935.

RECRUITMENT AND TRAINING OF ENGINEERING CRAFTSMEN.

Memorandum approved by the Council of the Institution for the information of members taking part in the Discussions on "Recruitment and Training of Engineering Craftsmen."

1.—Are Craftsmen Necessary?

Many are of the opinion that the age of the Craftsman is passed. On the other hand many who should know are of the opinion that craftsmanship was never more vital than it is to-day. It is true that the requirements of the craftsman of to-day are different from those of yesterday, but no more so than any other set of conditions that may be examined. It is a question of evolution, and those who are constantly engaged in the manipulation of human material know that one of their major difficulties is finding a sufficient amount of the human material that should come under the heading of "Craftsman."

It is the view of many that efforts should be made to recruit and train the necessary number of craftsmen—not only for to-day—but having regard to the requirements of the future.

In this connection we might, quite conceivably, ask ourselves "What is a craftsman," and here we shall find wide differences of opinion. Generally speaking, however, a craftsman can be defined as a man whose ability and dexterity are reflected in the quality, rather than the quantity, of his work. Such a man is able to produce results by the use of generally available machines and tools, and without the special machinery and facilities normally involved in manufacturing processes. This type of man is necessary both for toolroom work and for special "one off," and also for "small lot" production. He is also essentially part of any scheme for the production of the higher quality of work.

2.—How can this Training be best catered for?

There are still many who are convinced that the best method of training craftsmen is by going back to the old indentured apprenticeship system. Others are of the opinion that whilst this served a good purpose in the old days—where each lad could have individual attention—it is not likely to be successful under modern sets of conditions.

A further line of thought is to have something similar to the old indentured apprenticeship system, but in a large works this entails,

to be at all successful, an apprentice supervisor—one who shall see that the lads are moved about at frequent intervals, so that at the beginning they have that width of training which is necessary—and that running parallel with this there are educational classes either in the works or at technical schools in the evening.*

In this connection we must not lose sight of the fact that the training required for craftsmanship is not only training in technical matters, but that to achieve the fullest success there must be a mental and works training to make them suitable for the particular functions we desire.

Good craftsmen are distinguished by their interest in their work and a pride in the quality of the product upon which they are engaged. Their mental outlook must be such, therefore, that they should have a much wider interest in their craft than in the particular work that they may be engaged to do at any specific time. Breadth of vision and a training which will achieve this is, obviously, indicated as a line of approach.

In every case, where a serious course of training is proposed, the candidate, and the parents of the candidate should be consulted, and the seriousness and the responsibility of the undertaking to complete the course should be pointed out to them and agreed upon.

3.—How shall we Recruit our Prospective Craftsmen?

The term "recruitment" is liable to misconception as it rather suggests that ready-trained craftsmen are to be found and engaged. This is not the meaning of the Council. "Recruitment" is meant to convey recruiting the necessary material for training into craftsmen. Generally, there are three fields from which suitable youths may be drawn, first the elementary schools; secondly, the secondary schools with a technical school background; and thirdly, intelligent youths who can be recruited from the manufacturing departments In the first two classes mentioned success would, obviously, depend on the selection of the material brought in. In the third category there is a better chance of studying the lads while they are doing their ordinary work in the manufacturing departments. Many lads who seem restless and soon lose interest in such a department may probably make good material for craftsmanship training. An evidence of interest in a craft, exhibited by attendance at evening classes, coupled with good reports from same, could be taken as one ground for promoting a lad from a manufacturing department to a craftsmanship training course.

* For the complete syllabuses of the City and Guilds of London Institute in Machinists', Turners', and Fitters' Work see the Appendix, page 718. These syllabuses were drawn up by the Advisory Committee of the Institution of Production Engineers in conjunction with the City and Guilds of London Institute.

4.—Is a Scheme of Half-Time Working between Works and Technical Schools a Possibility?

This is a very debatable point.

A knowledge of what is being done would tell us that it is a possibility as it is already in action. It is very difficult, however, to get definite opinions as to the value of this method of working. Many still think that technical training should precede the works; others think in the reverse direction; whilst many others believe that the best scheme is technical training in the evening, running parallel with workshop training in the day-time.

The wide differences that exists between the requirements for various craftsmen used in engineering seem to indicate difficulties in laying down a scheme of training which would be suitable in all cases. Remembering, however, that the basis of craftsmanship, in its broadest sense, is a thorough understanding of what is to be accomplished, we are on safe ground in suggesting a preliminary training which is broad, which training can be gradually narrowed down until at the end of the course it amounts to a certain amount of specialisation so far as engineering is concerned.

5.—What is the best Scheme and who should initiate it?

If it were possible to determine which was the best scheme there would still be a difficulty on the question of who should initiate such a scheme. Should it be "part and parcel" of private enterprise which would depend on the various employers; or should it be the prerogative of the Government who would have to be, of course, forced to it by public opinion?

There are many viewpoints and many angles to be explored before a satisfactory answer can be given to such questions.

In the larger towns, where well equipped technical colleges present opportunities of studying such subjects as are required for his craft, the student would, naturally, take advantage of those, and this, of necessity, implies close co-operation between the employers and the various local educational committees.

In places, were no such educational facilities exist, the employers would have to take some action either of getting the educational authorities sufficiently interested to provide the necessary facilities for training, or, alternatively, formulate a scheme and carry it out themselves.

Undoubtedly, more opportunities are available for technical training in the larger towns, but, on the other hand, with the proper appreciation of the need for craftsmen, then possibly some of our smaller towns might, by the combined efforts of the various employers, provide ample facilities for the technical side required for craftsmen's training.

6.—Can we, as an Institution, put forward Proposals for the Future Training and Improved Status of Craftsmen?

There is probably no other institution so fitted to outline the possible proposals in this respect as our own, and there is no doubt that if we can put forward a feasible scheme, then it would receive the sincere attention of everyone connected with the engineering industry.

In this connection we have to remember that the training we are speaking of finishes at twenty-one years of age, and that in spite of all our training the trainee at this age is not a craftsman in the sense that we expect him to be at a period four or five years later.

While it is essential that greater efforts should be made towards the training of the potential craftsman, it is definitely very essential at the same time that every effort should be made to raise the status of the craftsman, so that those we have trained, or are about to train, shall become real craftsmen and remain such. The tendency to-day is for men who have had the necessary training for craftsmanship to get absorbed in the manufacturing departments, where much of their early training is wasted. It would appear, therefore, that whatever scheme is put forward for the recruitment and training of engineering craftsmen it is desirable that, running parallel with this, steps should be taken to improve the status of such trainees when they have passed out into the class known as "craftsmen."

THE RECRUITMENT AND TRAINING OF ENGINEERING CRAFTSMEN.

Paper presented to the Institution, London, Birmingham and Western Sections, by A.P.M. Fleming, C.B.E., M.Sc., M.I.E.E.

Introduction

MY original intention in preparing this paper was to cover different branches of the engineering industry and to deal with a wide range of sizes of works. On further consideration I decided that I could best be of service by describing in detail and, with some historical references, the scheme of recruitment and training of craftsmen employed in the company with which I am associated, since the principles involved apply to engineering trades as a whole, although the methods of application may require modification to suit different sizes of works. Such a presentation offers a field for discussion on the part of those whose experience is different from mine. I would emphasise that in putting forward the general plan adopted by my company, I claim for it no originality or particular features of excellence. I would only say that it appears to meet most satisfactorily the conditions with which we are confronted.

Description of Works.

The site is 130 acres. The total area roofed over is 54 acres. The main machine shop is 898 ft. × 444 ft. This houses five aisles and three main galleries.

"*A*" *Aisle.*—Stator and rotor punchings, turbine blading. The gallery of this aisle is devoted to insulation processes, manufacture of coils and to winding generators and motor stators and rotors, cooker and heater apparatus.

"*B*" *Aisle.*—Houses gear-cutting machines for double helical reduction gears, heavy machines for handling the big castings of the turbines and condensers.

"*C*" *Aisle.*—Houses smaller machines, turbine diaphragms, bearings, engine details and condenser auxiliaries. In the gallery above are automatic lathes for small parts, tool and die making, traction control, commutator and brush gear departments.

"*D*" *Aisle.*—Here large electrical machines are manufactured and tested. Outside is a separate armoured structure for overspeed tests.

London, December 5th; Birmingham, December 19th, 1934; Bristol. February 8th, 1935.

"*E*" *Aisle.*—A galleried bay accommodates above, departments for the manufacture of switchboards and cubicles, circuit breakers, iron-clad switchgear and motor control gear. Below the manufacture and testing of industrial motors is carried out.

West of the main buildings are a group of smaller buildings—canteens, warehouses, woodworking shops, and new works for the assembly of large switchgear. To the east are office buildings, central ambulance, fire-station, and sub-station. Beyond the road are the central costing, time-keeping and wages departments. Further east are the transformer shop and forge. Then come three large buildings under which are grouped iron and brass foundries, pattern stores and tank-shop, and tin-shop. South of the three main shops are more scattered buildings; a large tank-shop for transformers, circuit breakers, starter controllers; while a three-storey building provides accommodation for instruments and meters. Other scattered buildings are the school for apprentices, and a new office block, a combined purchasing department and stores, a central supply stores, a condenser testing station, and shops for moulded stone, moulded insulation, garages, etc., and at the extreme south the research offices and laboratories, and the gas plant. The main offices at the north end are housed in a six-storey building.

Employees.—Total employees at Trafford Park—11,276 on September 30th, 1934.

Hourly Roll	=	8,406
Weekly and monthly	=	2,870
Total		11,276

Analysis of Skilled Craftsmen at Present Employed at Trafford Park.

(1)	Mechanical Fitters	260
(2)	Electrical Fitters	360
(3)	Turners	217
(4)	Toolmakers	182
(5)	Pattern makers	98
(6)	Foundry men (moulders)	178
(7)	Core makers	58
(8)	Armature winders	89
(9)	Instrument makers	105
(10)	Tinsmiths	90
(11)	Copper smiths	14

Recruitment of Apprentices.

About twenty-five years ago apprenticeship in the engineering trades in this country was at a very low ebb, and the condition in our factory was not unlike that in most factories—apprenticeships were apprenticeships in name only, and very little conscious

effort was made to impart really satisfactory training. Viewing the position in our works it looked as though we were committing race suicide and that in a comparatively few years there would be no well-trained craftsmen to supply the wastage and turnover in the factory. In our case the position was aggravated by the fact that the works were situated some five miles from the heart of the city. Due to the prevailing conditions of employment for juveniles in the textile and other local industries, it was said at that time that there were five jobs for every boy. The result, therefore, was that on the outskirts of the city, firms like ourselves had to take the supply that remained after the more suitably placed employers had had their pick. At that time we had a labour turnover per week of something like 200 boys—a continual in and out flow of juveniles who were admitted, tried out by the foremen, and rejected. Bright boys, who came into the factory and liked the work, refused to be bound as apprentices although a nominal binding arrangement was in force, because they found their opportunities of transfer and if they so desired, eventual change to other firms, facilitated by remaining free. It was only the less satisfactory juveniles who became bound as a measure of self-protection and insurance of employment for a number of years ahead.

The recruitment at that time was done at the gate or by post, or through the recommendations of relatives and friends, and the incoming boys were passed straight to the foremen who chanced to have vacancies, and the selection was made at that point. As I have already pointed out, the character of the supply was deplorably poor.

After a careful survey of the whole situation it was decided to establish a works school, to which boys would be admitted for eight hours per week during working hours and taught subjects pertaining to their trades, and in addition some continuation of their general education was attempted. This school was also to serve as a means for bringing all the young apprentices, and particularly the new recruits, under close scrutiny. The establishment of this school and the planning of a systematic course of training became widely known with the result that in a year or two, applicants exceeded vacancies in the proportion of something like 20 : 1.

Selection.

In those earlier days the interviewing of incoming juveniles was done by three members of the education department who made the first sifting. The selected candidates were then sent on to the foremen for approval. Subsequently the foremen were glad to leave the selection to the education department staff. This was an important change, because it would not necessarily follow that an apprentice would complete his time in the department by which he was origi-

nally chosen. The decision of the interviewers, when adverse to the applicant, was frequently challenged by relations and friends, and to counteract this a written examination was established. This examination included such questions in arithmetic and elementary chemistry and mechanics as a bright school-leaver should have no difficulty in answering.

Handy Youths.

At this period a very large number of boys who were not regarded as apprentices or likely to become such, were employed as handy youths, machine operators, bench hands, etc. It was decided, as far as possible, to apprentice youths in order to ensure that they got a systematic training and a reasonable guarantee of employment and also to prevent boys from entering into blind alley occupations. All the boys then in the works were given the opportunity of interview and examinations for apprenticeship.

Planned Control of Numbers.

About ten years ago, from past experience and from forecast of the future, a very careful estimate was made of the numbers of apprentices in the different trades required to supply wastage and to meet the expansion of the companys' business. This estimate had to forecast probable requirements five years ahead. From that time such an estimate, which is corrected from time to time as business conditions necessitate, has been made each year.

Examination Changes.

Up to about five years ago considerable changes had to be made from time to time in the nature and character of the examinations, owing to the increasingly improved quality and quantity of the candidates coming forward. From time to time certain psychological tests had been applied, but these were abandoned. Originally the examinations relative to the interviewer's opinion were weighted in the proportion of about 4 : 1. In recent years about equal weight has been given to the written examination and the interviewer's opinion. Two series of examination papers are set based on the type of school attended and the age of leaving, one for senior school boys and early leavers from secondary and central schools, and one for more normal secondary school and central school boys and others of 16 years of age, who have attended evening classes since leaving school. From time to time we have checked our method by passing for apprenticeship boys who have failed to reach the 70% standard set in the examinations. Almost invariably these have been adversely reported on by their foremen who have not known that the boys in question had been accepted as an experiment.

Juvenile Employment Bureaux.

Very close relationship has been established with the local Juvenile Employment Bureaux, which are advised prior to the times of our quarterly examinations.

Interviews.

In interviewing and selecting boys, attention is paid to many factors among which, in addition to results of examinations, are: (1) Physique and health (previous illnesses, etc.) judged by appearance and obvious physical condition; (2) knowledge of general everyday domestic and local engineering; (3) hobbies; (4) home circumstances and conditions (weighing in favour of candidate where it is, usually unconsciously, indicated that opportunities for development, etc., have not been good—provided that it is felt that the boy will take advantage of guidance and facilities for training when backed up by the company); (5) home reading; (6) ways of spending spare time; (7) location of home with reference to travelling facilities to and from work and its bearing on attendance both at work and at evening classes; (8) occupation of parent or parents (traditions, etc.); (9) relationship to employees; (10) previous type of employment if any (reason for leaving); (11) type and particular school attended; (12) manner; (13) appearance and attitude; (14) candidate's own reasons for desiring apprenticeship; (15) choice of trade; (16) alternate ambitions; (17) complete medical report from company's doctor after starting work.

Supply.

The supply of trade apprentices comes from four types of school, viz.: elementary; central; secondary; junior technical. Normally about 150 boys are selected each year but up to date this year 242 probationers have been taken on. The present division among schools is:—

Elementary	48%
Central	14%
Secondary	14%
Junior technical	24%
	100%

In 1930 a full investigation of the apprentices who had (*a*) completed apprenticeship and (*b*) commenced apprenticeship, was made and this included an analysis of the number of boys entering from each main type of school and their ultimate standing and employment at twenty-one years of age. As a result, the table of numbers of apprentices was extended and a definite input for each age for each year between fourteen and seventeen years of age, inclusive,

was established and a controlled total of boys in training at ages eighteen, nineteen, twenty and twenty-one arranged for. The investigation also emphasised the ability of the boy who had been at a junior technical school and it was arranged that whereas only 8% of the boys admitted each year had been at a junior technical school, in future the proportion should be 30% with the proviso that in selecting this much larger number of junior technical school boys emphasis on their ability in craftwork should be given and not necessarily all those boys accepted who had the best academic records.

The result was that those who came high up in the results were accepted (with a view to promotion, later, to test bed, drawing office work and shop staff, etc.) and, also, those who came relatively low down in average examination results but were highly placed in the more practical side of their school work. Junior technical school boys do not take the usual entrance examination except for the papers in "Engineering Knowledge" and "Engineering Interest," but their headmasters submit complete results of their own school examinations in each subject, homework, etc., and these are carefully scrutinised.

An increasing number of secondary school boys apply who recognise the opportunities for promotion from the trade apprenticeship course and who have no desire nor intention of remaining as craftsmen and it is difficult to keep the input of this type within bounds, as it must be kept in mind that the prime object of the trade course is to provide well-trained artisans and encourage boys without the advantage of secondary school education to earn promotion and to allow natural ability to find an outlet where home conditions and other causes have retarded development until genuine merit has, under the influence of training, an opportunity to prove itself.

As far as practicable the number of boys entering from each type of school is stabilised and admittances controlled so that about 110 apprentices complete their apprenticeship each year and commencing in 1936 the proportion will be 30% junior technical school boys, 50% senior elementary school boys, 12% secondary school boys (most early leavers and those who have not been able to keep up to the normal pace of these schools) and 8% from central schools.

Co-operation with Sources of Supply.

It has been long recognised that only by establishing the closest co-operation with the sources of supply, including the various types of schools, the Juvenile Advisory Committee attached to the Employment Exchanges of the Ministry of Labour the Juvenile Employment Bureaux of the local education authorities, etc.,

can a really satisfactory supply of probationers be obtained. This contact is made in a vairiety of ways by lectures given by the education department staff to the schools, by visits to the works of schoolmasters and others associated with the local educational work, by members of the staff serving on outside educational committees, etc.

Reviewing the selection of apprentices over a period of twenty-five years, the most astounding factor has been the very marked improvement in quality obtainable. This is due in the first place to the fact that by establishing an attractive course of training a large number of boys apply for admission. Added to this there has been in some directions attendency for the bright youths not always to seek the black-coated types of jobs, and moreover masters and teachers who have seen the training schemes in operation have begun to appreciate the possibilities offered by apprenticeship courses in industry for their brighter pupils. A point of importance to be noted, however, is that one must be careful to avoid the lowest strata and the highest strata ; the lowest are not worth while the expenditure of time and effort in training, either from the firm's point of view or from a national standpoint. The upper strata are not suited to work on the bench and there is therefore the risk of having in the trade apprenticeship system too large a percentage of boys who are really entitled to promotion, so that the plan of training craftsmen defeats itself.

Training.

Boys selected for employment are drafted into the departments as errand boys for approximately six months unless over sixteen years of age when they are put at once on to simple bench or machine work. Boys entering before fourteen and three quarter years of age are given two periods of errands for about six months each, in different parts of the work and as far as possible, on a different kind of work, e.g., a boy employed first in a machine shop is put into a fitting and erecting shop for the second period. During the second period the boy's own choice of trade is ascertained and in almost all cases the boy is bound to his first choice of trade ; but if this cannot be arranged he is able to take up his second choice. The following trades are available :—

		Number of Apprentices.	*Number of Craftsmen.*
* (1)	Fitting (Electrical) ...	250	360
* (2)	Fitting (Mechanical) ...	48	260
(3)	Turning	20	217
(4)	Moulding	21	178
(5)	Coremaking	10	58

		Number of Apprentices.	*Number of Craftsmen.*
(6)	Patternmaking	18	98
* (7)	Instrument-making ...	92	105
(8)	Tinsmithing	8	90
(9)	Coppersmithing	2	14
(10)	Tool-making	30	182
(11)	Armature-winding ...	6	89
		505	1651

* These trades supply the great majority of those entering test beds, drawing offices, research, shop staff (production, inspection, process and rate, etc.), and the number remaining as craftsmen are in the proportion given in the second column.

Once a boy has had a three months' satisfactory trial on work in the trade he wishes to take up, he is bound to that trade until he is twenty-one. The father, mother, or guardian is invited to the works and that member of the staff who will supervise the boy throughout his apprenticeship, explains the system of training. He will indicate the general lines of the boy's practical training in the shops, his works' school work, the outside evening classes he should attend, the necessity for the parents to co-operate with the company in the interest of the boy. The opportunities for gaining more advanced training leading to promotion are discussed, and, also, the boy's medical report and the opportunities to share in the social and athletic activities of the trade apprentices' own association. The head of the department meets the parent and boy and "rounds off" the interview impressing upon the parent and son that the future opportunities for the boy depend upon his own energy, keenness, and capacity to profit from his training in all its aspects, and that the company gives the utmost facilities according to the boy's own progress. The "Binding Form" used is a moral undertaking between the company, the parent, and the boy, and is not a stamped legal document. Since its adoption some twenty years ago it has not been broken by the company except in a very few cases where the boy has repeatedly and seriously violated the conditions governing his apprenticeship and, on the other hand, the agreement has been broken by the parent in an astonishingly few cases—the number of occasions when a boy has been withdrawn without the willing consent of the company have been about half a dozen out of some 1,200 to 1,500 boys. A parent is always allowed to withdraw a boy if there is a good reason, such as ill health, the removal of the parents from the district, or definite agreement that some other occupation is more suitable.

The Works Training consists of two parts : (*a*) Practical training in the shops, and (b) instruction in the works' school.

(*a*) *Practical Training :* In order to ensure that the needs of apprentices with regard to practical training are adequately met, a number of apprentice instructors are engaged. These men are skilled craftsmen who combine with their trade capacity a strong interest in every phase of apprentice training, and possess marked teaching ability. They co-operate with the foremen in supervising the apprentices and are primarily concerned with giving the latter definite instruction in the practice of their trade—teaching the proper use of tools, measuring instruments, and processes.

An important feature of the training is the introduction of practical examinations whereby the skill of the apprentice is tested at regular periods. Such examinations are held every six months and the work required is not an exercise definitely devised for the occasion but an ordinary job or part of a job passing through the shop in which the apprentice is engaged and which is required in the ordinary course of works production.

(*b*) *The Works School.*—The probationary trade apprentice commences attendance at the works' school in the first session after he joins the company. This first session is spent in learning to sketch—not " draw " in the draughting sense—but the elements of freehand sketching, with principles of projection and development of surfaces to enable him to express ideas on paper and understand shop sketches. This is followed by a revision class in general science with particular reference to the principles which he must understand if he is to appreciate fully the instruction given during the next three years' attendance in the works' school, when he follows a progressive course of study appropriate to his trade, which deals with hand tools, machine tools, materials, processes, measurements, methods of assembly, erection, etc.

The Welding School.

With the rapid development of fabricated apparatus, the dearth of well qualified welders made it necessary to adopt special means to train a large number of workmen in the various welding processes. In addition, as manufacturers of welding equipment it was found advantageous to accede to the frequent requests of customers to either recommend suitably trained operators to them to work our machines or to train their workpeople in our own shops to ensure that the best use was made of our equipment when installed. For this purpose, the welding school, in which instruction is given in D.C. and A.C. electric welding and atomic hydrogen welding, was set up. Selected workmen between the ages of twenty and thirty are trained for a period of from six to eight weeks and then drafted to normal productive work in the welding shop. About a dozen men

are usually in training at one time. The school is well equipped for both practical and theoretical instruction. It has a well-arranged laboratory in which the main welding equipment consists of single-operator sets of the M-V. standard type. It is also provided with the necessary equipment for practical demonstration of welding applications and methods of examining and testing the characteristics of welds made under various conditions and to meet various requirements. The schoolroom for thecretical lessons is equipped with a projecting lantern. The practical instruction consists of a series of exercises carefully designed to illustrate fundamental principles and correct methods. Commencing with elementary exercises in striking and controlling the arc, the practical work includes the making of joints of all kinds, not only in horizontal positions but also vertically, inclined and overhead. It also includes exercises in filling in and building up, for the reinforcement of joints and also for making up defective, worn and broken parts.

The theoretical lessons are alternated with practical instruction and exercises, and are planned to teach the student sufficient elementary theory of the materials and processes to enable him to carry out his work intelligently. The subjects of theoretical instruction include elementary metallurgy of iron and steel, chemical characteristics and physical properties of these metals in various forms—cast, forged, etc., the phenomenon of thermal expansion and contraction, the elementary chemistry of oxidation, the use of iron and steel in engineering construction, the technique of welding, the use of bare and covered electrodes, the various methods of jointing and kinds of joints, methods of measurement and the use of drawings.

Micro-Motion Study in Relation to Craftsmanship Training.

Many people have regarded the work of those engaged in micro-motion study as being applicable to repetition and " semi-skilled " work only. When it is realised that micro-motion study is largely : (1)The analysis of waste effort of workpeople who have been left largely to themselves as regards their method of producing the apparatus they manufacture ; (2) the teaching of the use of both hands to increase speed and avoid fatigue ; (3) the designing of the lay-out of material in bins, containers or on the bench with the same objects ; (4) the placing of tools when not in use according to a plan, and similar commonsense methods of working ; it will be also appreciated that this study can do much to increase the efficiency of any craftsman however skilled, if his training and experience have not enabled him to consider, to a maximum degree, all these matters for himself. It is unlikely that any craftsman can rightly claim to have acquired a maximum result in all these lines of potential increased efficiency. Apprentices are taught by older craftsmen in the traditions and art of their craft, but high standard

of result is the primary consideration and time of operation is secondary. In addition, in most cases, fatigue is not consciously considered and its effect on the resultant work is not often recognised except in extreme cases.

The past twenty years have seen a great increase in production due to the development of highly ingenious machines and new materials, and so the number of man-hours necessary to produce a given product have been much reduced. It is agreed that craftsmen have undoubtedly speeded up their methods but that such methods have been largely their own uncollated efforts, and the same thought and scientific planning has not been devoted by manufacturers to this opportunity for increasing efficiency as has been devoted to the material and machine side of their responsibilities. Little or no conscious effort has been made to train present and future craftsmen in the principles underlying micro-motion study in their relation to :—

(1) Ambidexterity.
(2) Arrangement of bins and containers for material to save time and movement and avoid unnecessary fatigue.
(3) The placing of tools in recognised positions to avoid undue movement and avoid hesitancy in selecting tools for use.
(4) The careful analysis of methods used, their consideration by experts and the craftsmen concerned, convinced, contentedly, with the adoption of suggested methods of working, discovered by the intelligent analysis of the job, will enable him to do his work as well, if not better, but with greater efficiency in time and less fatigue—with consequent benefit to himself and his employer.

It is realised that this must come slowly due to the conservatism of the craftsman, and it also requires the abandonment of traditional methods in many cases. It is therefore with the present and future generations of apprentices that most effort must be made to inculcate the aims and principles of micro-motion study. Such instruction is now a part of the M-V. works' school training course, and the apprentices' attention called to its application in the everyday practical work carried out in the shops.

Part-Time Education.

It will be appreciated that it is very desirable that a boy who wishes to make the most intelligent use of his practical training and experience should continue his technical education. While the company does not require its trade apprentices to attend evening technical schools those who do so are given every encouragement, and in this connection the company receives monthly reports of attendance and progress from the principals and headmasters concerned. The company also makes gifts of plant and apparatus for use by the technical schools which also recruit a good proportion

of their part-time teachers from the company's staff. Ten scholarships are awarded yearly to the trade apprentices on the results of examinations at the local evening technical schools and colleges. The holders of these scholarships, which are of two years' duration, attend a part-time day course of technical instruction at the Manchester College of Technology or the Royal Technical College, Salford, for one full day per week. The company pays all fees, books, instruments, etc., and wages during the time spent in instruction. The apprentices thus trained ultimately gain associateships of the colleges concerned, national certificates, and in some cases university external degrees.

Promotion.

While the primary purpose of the trade apprenticeship course is to train skilled craftsmen, it is recognised that a very fair proportion of these will rise beyond the bench and that avenues for promotion to staff jobs must be available.

The apprentice who is ambitious and capable of advancement usually completes the "craft" side of his school work by nineteen and then, if he has also reached a sufficiently high standard of technical training at evening classes at local colleges and schools he attends a drawing office class for two hours per week for six months and, also, another two hours per week during the same period at a pattern-making class. It is realised that every draughtsman could spend at least six months in a pattern shop with considerable advantage to his future work, but in practice it is not possible to arrange this and the patternmaking course is designed to take the place, as far as possible, of this experience. Such apprentices are then transferred to drawing offices for six months' trial and either retained there or given training to fit them for some other appropriate staff position in works production, inspection or processing and ratefixing, research, commercial work, outside erection, etc.

The following shows the distribution of apprentices in various types of employment on the completion of apprenticeship :—

Type of Employment on completion of apprenticeship	Elementary Schools %	Central Schools %	Secondary Schools %	Junior Technical Schools %
Craft work on bench or machine	74.5	40	23	10
Test Hands	7	7	18	28
Technical Employment :—				
Works Staff, Production, Processing, etc.	5	7	9	14
Drawing Office and Design	13	43	46	45
Commercial Departments...	.5	3	4	3
All types of post apprenticeship employment	100	100	100	100

The Apprentice Association.

In addition to the attention given to the technical training of apprentices the company encourages them to develop their own social activities, and facilitates the development of these functions. All members of the Apprentice Association are divided into two sections, the trade section and the college and school section, each of which elects a committee that is directly responsible for the programme of social activities and the organisation of athletics. These committees, in turn, elect some of their members to form the Apprentice Association council, which controls the Apprentice Association's activities. Most beneficial results have been derived from this system of co-operation, whereby the potential members of all branches of the company come closely into touch. The apprentice council, consisting of apprentice members, together with the representatives of the education department, has achieved a very fine object by developing a general *esprit de corps* amongst apprentices and a mutual appreciation between the two sections.

Each section has a large annual programme of varied activities that are attended by many senior members of the company, providing opportunity for apprentices to meet the senior staff on an ordinary social footing. The arrangement of such social and athletic activities affords considerable training in organisation, which may later be turned into account in higher administrative posts and in the larger fields of the civic and national community.

Athletics naturally occupy a prominent position in the apprentices' programme. Football, cricket, swimming, annual sports, boxing, and shooting have been arranged, and a very keen athletic rivalry exists between the two apprentice sections. A quarterly magazine, *The Rotor*, is produced, and has a circulation of well over 2,000.

Conclusions.

It is important in every concern, however small and limited its facilities for training, to have some individual who is responsible wholly or part-time for the supervision of trainees. Where conditions do not permit a full training to be given, the very utmost that the firm can do should be carried out. In the case of firms who can train men, it seems from every point of view, both as regards the firm and nationally, a matter of importance to develop the inherent capacity of young people while they are still of a mobile age. Here the large concerns, who are better equipped for the purpose, should look upon this as something of a national responsibility and should not be too concerned if their turnover of younger trained men is somewhat high due to the flow of these young trainees into concerns that can utilise their services but have not the same facilities for training.

Discussion, London Section.

MR. C. C. FERGUSON: Mr. Fleming certainly has given us some excellent material to think about. Personally I am particularly interested in the four groups forming his sources of supply of juvenile male labour. We were reminded of the improvement in the material available for recruitment as apprentices to-day as compared with that of twenty or thirty years ago. I submit that twenty or thirty years ago the material which you were getting from your elementary schools—standard IV or V which were the standards referred to—was definitely better material than you are getting to-day from elementary schools, for this reason, that boys are creamed first of all for technical schools; they are creamed for central schools; and they are creamed for secondary schools. What you have left are simply, for want of a better term, what are known to engineers as "duds."

You referred to the question of asking the applicants for apprenticeship which particular section of industry they wished to enter. If they have definitely set their mind on one particular section is it advisable to put them into that section or is it not rather better that you had a youngster with a perfectly open mind so that you could mould him according to the wishes of your tutors rather than to have one with a set purpose before he had entered into an engineering workshop?

Your training scheme was referred to as being only, or chiefly, for craftsmanship. I wonder whether that is the correct way of looking at it? Surely what we want to provide and what we in London endeavour to provide in conjunction with the educational establishments, is to give every boy an equal opportunity for reaching the higher positions, but we do not attempt to keep 75% as craftsmen. Those boys who have greater ambitions and who wish to get on to the higher rungs of the ladder will definitely reach them whether they stay in the company which trains them or whether they go elsewhere, and it certainly is the policy of the companies in London and district to train as many of these youngsters as possible to occupy executive positions and minor positions on the executive staff. I would refer here particularly to the foreman class. There is difficulty in obtaining the right class of foreman to-day. There is also a difficulty in obtaining good machine tool setters, and good universal machinists, classes of labour which were not mentioned by our lecturer in any way this evening.

The different schemes of training apprentices were mentioned and it was stated that in some works they put an apprentice with craftsmen and in other works they have a training school. I suppose

those of us who are connected with the training of apprentices would look upon the adoption or otherwise of any particular form of training rather in this way, as to whether it would be more beneficial to have a training bay or a school for the apprentices, chiefly for this reason, that it is better to keep these young fellows on their own and away from certain undesirable influences which one does meet with in the modern engineering establishment and elsewhere.

I must say that I am not at all surprised that your company finds difficulty in retaining craftsmen; I can imagine that other companies are only too pleased to take the men you train. Our difficulty in London is this: the engineering employer who trains his workpeople and gives them a very definite training in conjunction with educational establishments is up against the difficulty that in London there are many firms which are not manufacturing engineering firms at all—the engineering department is ancillary to the main production. Such firms are only too pleased to take ex-apprentice fitters, turners, tool-makers and skilled machinists, and pay them as key men and retain their services on the maintenance staff. These firms are not doing their bit by training their own apprentices. They prefer, because of their rather sheltered position, to pay a rate which will entice them away from such firms as your own who do definitely lay out an excellent training scheme at a great financial outlay by the company. That is a problem which we have to meet in London.

The works school I was particularly interested in. Our own institution has been associating with the City and Guilds of London Institute for the purpose of drawing up a syllabus for the technical training of machinists, fitters and turners, and the scheme is definitely now becoming more known and it is being adopted by technical colleges, and employers are advocating its adoption by the apprentices and people with whom they are in contact. We have tried to cover in that syllabus as much as we possibly can on the practical side, and by leading up from that course to our own graduate examination course for this institution, we are endeavouring to produce men who will be eventually qualified to hold important posts in the industry. In connection with that, I would like to refer to a scheme of progress reports, not only for apprentices but for shop-boys, which we have run in London now for about four or five years. Such reports are sent periodically to the parent or guardian of the boy, and on the report is entered the class of work the youth is engaged on, the department, and his progress during the past few months; there is also a space provided for the report received from the technical institute which the lad is attending, and by that means we do keep not only the parent or the guardian in contact with the employer but we also advise the parent through

the proper channel as to the boy's progress; and parents do definitely appreciate that action.

Another thing also which I do commend to you, gentlemen, is the case of unindentured apprentices, and I feel this rather acutely because as Engineering Advisor to the Ministry of Labour Public Secondary Schools Committee, I have to see at the Ministry of Labour offices very frequently youngsters who have been engaged in engineering shops, either as youths in training or learners, or they have been given an undertaking orally that they will be taught a trade. After about two years they have been put out, with nothing whatever to show as to the class of work they have been engaged on. Some firms have for that class of youth what they call a leaving certificate. Such a certificate is given to the lad, and on it is stated the classes of work and the departments the lad has been engaged in, and he takes the certificate to his prospective employer who retains it, and then if he finds it necessary to discharge him at the end of eighteen months or two years, the subsequent training period is entered on the certificate. That gives the lad something to look to when he has reached the age of maturity, and I certainly do commend that to you, gentleman, as something to think about because it is a serious problem for some of these young fellows who are not indentured apprentices.

Reference was made to training in small firms and the responsibility of training being on the shoulders of one man. I certainly agree with you there. I submit that it is the business and the duty of every foreman and every person in a position of trust to-day in an engineering establishment to take an interest in the juveniles under his control. Such men in responsible positions are definitely there for some purpose; they should be there amongst other things for the purpose of training and not only making engineers of the young men under their control, but, as you remarked yourself, good citizens.

MR. FLEMING: I appreciate very much the valuable points raised by Mr. Ferguson. I note the last point, which brought in my mind a thought regarding the importance of having the right camaraderie between the young man who is growing up to manhood and the various people in the concern. They may be staff men or men in any way employed in the organisation. That was just one point in connection with the Apprentices' Association which I apparently omitted to emphasise. In that association there are two types of people: there is the young man coming from the university who is going through a practical period of apprenticeship for a short period of two or three years as he case may be, and the men from public schools who may be spending four years who never intend to become craftsmen but who intend to get a workable knowledge of the products and who will come into a certain department such as

design, manufacture and commercial work, and so on, and the best of them will go rapidly up the scale. Then we have this group of young men who come in primarily to learn a trade. These young men meet together in their association ; many of the functions they attend together—social functions ; they play games together ; they get to understand each other. If you can picture ten years hence there you have some of the men who, with a better technical start or a better general education. will climb up the scale and become prominent members of the firm's staff. The association means more in the co-operative working than any other means that I can think of. We pay the greatest attention to it, and that is perhaps one of the reasons why in the whole history of our company we have never had a labour dispute because of any dispute outside. If when men have had to be loyal to the company or loyal to their unions they have been rightly loyal to their unions and they have gone out with their unions, they have straightened up the whole place before going and looked forward to the time when they could get back. That is due to the fact that we have now through the whole organisation these young men who are trained in the place, treated decently, brought up shoulder to shoulder with young men of a different type of education, and opportunity to go on to higher levels. It is to my mind a most important thing that question of getting the right attitude of mind throughout the works. You get it again with the foremen ; they are the most helpful people to us in any troubles or problems. Coupled with these people are leading trade unionists, and it is quite a common thing to call in the chairman of the works committee or some of his colleagues to advise on points to which we think they can give helpful information.

I was interested in the point regarding advice to parents. We keep parents informed as fully as we can of the progress of the boys and we are always glad to see the parents come in. We invite them from time to time into the works to see what the apprentices are doing, and we have a staff function which enables them to do that. We are also most interested in their receipt of our medical report because if a boy is reported by the medical man to have minor defects which can be remedied we put that up to the parents to see to and they are usually most appreciative. If, as sometimes happens, we are advised that the boy should not continue in the kind of occupation that engineering involves we then arrange with his parents to give plenty of time to get him elsewhere.

You referred to the fact that many firms in the London area are not fulfilling their obligations in the proper training of men and prefer probably to absorb them elsewhere. That is an attitude of mind which was common in the North in years gone by, but it is not so common to-day. I think it is a very short-sighted policy,

quite apart from the fact that morally and ethically it cannot be supported.

On the question of foundry trades, we have nothing like the choice for the foundry trades that we get for practically every other trade. That again I think is due to the fact that it seems to some boys perhaps an undesirable kind of trade, although we often do find people who are most enthusiastic about it. Personally I think that if I had to take a craft I would take a foundry trade. Incidentally, the modern methods of fabrication by welding are cutting into the heavier engineering foundry trades quite a good deal as far as I have seen it in the North.

On the question of whether boys in the shops should be segregated from undesirable workmen by placing them in special shops—I can quite appreciate that this is an important point. It does not rule with us to any extent. We considered the matter very carefully, but I rather came to the conclusion, after a good deal of thought, that the average vices of the workmen were such that (for instance, getting a little money on a horse occasionally) they were in the blood any way and the boy would probably develop them. Again, we happen to have an extraordinarily high grade of workpeople—I mean high grade in the sense that they are thundering good fellows, and I do not think we would now under any conditions revert to the separate shop for training, although we did very seriously consider it.

You rather twitted me with not having mentioned foremen in special cases. I was down to talk on a particular subject, and I stuck to my last. I could speak at great length on the grief we have suffered in the matter of selecting, training and firing foremen.

With regard to advisory bodies, you mentioned that I referred to central schools. That was not altogether my fault. Some years ago I was invited to serve on a committee dealing with central schools in Manchester, and I was not able at the time to give attention to it, but one of my staff did do so and has done ever since.

On the question of choice of applicant for a trade, as to whether that is wise or whether one ought to take a boy and mould him to what one thought was the right thing for him to do, my own views may be quite wrong, but personally I have a feeling that when it comes to any particular kind of job I do like to treat a boy as I would be treated. If I had made up my mind to be a patternmaker I would jolly well be a patternmaker and nothing else. I have thought that if a boy wants to follow a particular trade it may be because his best pal at school has gone to that trade, or because his father was or was not in that trade ; but he has some idea he wants to be in that trade. If you give him plenty of opportunity to look at the job, to spend time in it and to see also other trades, I think you have got a fair chance of giving him by self-selection a chance to decide—that is providing the opportunity is there. We have

never attempted to grade by examination boys into such a category ; we have never attempted that, although we may be quite wrong, but I lean to giving the fellow a chance to settle things for himself if he can. Having had six months and sometimes twelve months running about the place, which gives him a chance of seeing and learning a lot, he does have three months of probationary period actually in the job that he thinks he wants to follow. If during that time he thinks he does not like it, we change it.

On the point as to whether the material for recruitment is better. I have no doubt about it. You should have seen those boys of twenty-five years ago and the crass stupidity that they could show. It may be that we happen to have such a wide choice to-day, but I must confess that in our experience we are undoubtedly getting better material.

MR. J. H. CURRIE : I have enjoyed the meeting very much indeed, and I am particularly grateful for having been asked to come here. What I thought might be the most useful contribution is to give you a very brief description of a system which I investigated in Germany three years ago on behalf of the London County Council. My work is concerned with inspecting technical schools, and I was sent over to investigate this problem of training craftsmen for the engineering industry.

This system is known as the Dinta system and it exists for training recruits and apprentices for the engineering and one or two other allied heavy industries. Its essential point is the recruitment and training of craftsmen. Another very interesting thing is that it is done entirely by the employers. There is no assistance whatever given by the Government or by any Local Government, and the general consensus of opinion on the scheme that I got from a number of big employers was that it is successful.

The main idea is to select boys and provide a special training for them—those who want to become skilled craftsmen in engineering, mining, building, and textile industries. The system can be carried on in any works where a number of apprentices are employed, and it is usually organised and controlled by a specially trained Dinta engineer who looks after the social and the physical welfare of the apprentices and supervises their work and trade. The essential features are these : First of all they are selected and placed by psychological tests. There are one or two interesting things about these tests. They have been tried on some thousands of people ; the greatest importance is attached to finding out whether or not a boy has the ability of what is called " thinking in three dimensions "—that is to say, he has not got a flat imagination. A brief illustration is this : the boy who can readily and fairly quickly visualise any solid by its representation in ordinary drawing—he knows exactly what kind of a section to look for, where to look

for it, and he can visualise the job he is making from its representation on a flat plane. It is claimed that this can be tested with some reasonable degree of accuracy. That is one of the most important things. They also take his school record, and give him all kinds of general intelligence tests—colour-blindness and manual dexterity, and so on. The next thing when they have chosen their boys is that they are sent for a four year's apprenticeship; two years are spent in a special workshop and the remaining two years are spent in the ordinary workshops of the particular firm to which they are sent.

This scheme can be and is carried on in various works throughout Germany. If you are an employer you have a family of apprentices. You send to the Central Institute for a Dinta engineer and get this special training. The third characteristic is the emphasis placed on training in social ideas, citizenship, and on physical training. The boy is thoroughly looked after for the whole of that four years, not only with regard to his physical welfare but also his social welfare, and he is given works school training in addition, as well as a very thorough training in the workshops concerned.

One other interesting thing is this; there is a very definite objective of the cultivation of a co-operative spirit. I saw the people actually at work in their workshops, and judging by those boys the scheme was a very great success; they were all happy; they turned out first-class stuff, and generally speaking I was told they have no difficulty whatever in getting really good jobs when they have finished. They became fully-fledged journeymen after four years. They had then a formal ceremony to go through, and were made to feel that they were somebody of real importance.

One or two simple things concerning the workshop training—there are special workshops in the first two years; the boys went through every single department and got a general training all round, and then got two years doing production work in the ordinary workshops of the factory concerned. They were still under supervision and attended their works school and still had their examination to look forward to (or otherwise!) at the end of the year.

In conclusion, I would like to raise one or two other questions that have struck me; one is that this scheme that I saw, and the scheme that Mr. Fleming has described, is what I call an easy job. You have got the heavy stabilised industries where you have a fairly high proportion of skilled men. As I see it our big question is this: "What are *we* doing in London, which has a problem all its own. We have in London a great number and wide variety of light industries carried on in small factories and larger factories that are doing mass-production work. What sort of chance is there for a boy to get trained as a craftsman; what sort of chance of employment is there for him if he does become a craftsman? Is the value of

skill now to be centred on the machine rather than round the material? Ought we not to ask for someone who is more adaptable with regard to the handling of machines, as well as being capable of skilled manipulation of material?

MR. FLEMING: Mr. Currie has raised some interesting points. There is that important point about the light industries, particularly in the London area where you are concerned with the specialist type, where even if the boy gets a footing he cannot have that insurance policy which a really first-class training in trade gives him, and get a job elsewhere. That seems to me to be the important factor with a boy—after all, it is his copyright—it is an insurance policy to him as compared with that of the boy who becomes a specialist or goes into a mass production job. It does present a problem that is important. I have often wondered whether it may be possible in some districts where the light industries abound to get some sort of co-operative training scheme which would enable a boy to work around a number of factories if you could get them to co-operate, and get a wider training and enhance his possibilities of always being able to get a job because he is much more many-sided than if he spends all his time in one place. It is an important point, and I suppose it does come down to the boy becoming just a specialist with a highly developed skill in one particular kind of dexterity.

I was particularly interested in Mr. Currie's description of the scheme in Germany. I understand that the boys there migrated into other parts of Germany and went right throughout the country. Germany has put up some astonishingly good schemes, but one wonders, when trying to consider the application of it in other countries, whether there is some sort of national or inherent personality or difference of some kind. Somehow the highly finished and highly efficient schemes that we have seen from time to time on the Continent do not seem to be capable of being transplanted in their entirety: they have to be modified to adapt them to our particular temperament. The scheme put forward by Mr. Currie is worthy of the utmost attention, and one ought to consider to what extent one could take out of it those parts which could be adapted to our working here.

MR. W. C. PUCKEY: There are two points mentioned by Mr. Fleming that interest me. First of all, in relation to the boy of to-day as compared with the boy of twenty years ago. It is very refreshing to hear him say that the boy of to-day is more finished than the boy of years ago; it is some recompense for the higher educational rate. The second is in relation to the value of an examination. We have heard a lot of criticism of the examination system and it was good to hear Mr. Fleming say that usually the boy who did well in examinations did well in his subsequent career. It is

all the more refreshing when one reads in the papers that about 99% of our politicians at the school speech-days (of which they seem to be so fond) state that invariably they were at the bottom of their form : it confirms one's opinion of politicians.

Mr. Fleming has been fortunate in being connected with such a a large firm. I think he would be one of the first to realise that things are very much easier from one point of view when you are connected with such a large organisation. You can plan things very much more satisfactorily than you can with a smaller firm. Recently we were given to understand that about 90% of the firms in this country employed less than 500 people, and also that a very large proportion of that 90% employed less than 50 people. I think you will agree that it is very difficult indeed to formulate and to practice such schemes as Mr. Fleming has presented to us this evening with such remarkable facility with a firm that has about 50 employees.

I would like to have some information as to the best methods that one can adopt in such a small firm. My firm is possibly what one might call a " medium " firm and possibly the methods that we have there might be of some interest. We invariably get more applications for apprentices than we can take on. We make a point of asking the parents to come with the boy, so that we get a general impression. If the conditions are reasonably favourable that boy has to come along for an examination, and I pay particular stress at this examination to dexterity. As well as theoretical knowledge he must have a certain amount of dexterity. If the boy passes this examination satisfactorily he then waits until a vacancy occurs, and we get him along on three months' probation. If he is satisfactory at the end of that period he is an indentured apprentice for three or four years and pays at the rate of £10 per year, the money going to the sports club. The idea underlying that is that the boy gets most of his knowledge and skill from the men, and therefore the money paid by his father goes to something connected with them. The boy then goes into the factory and goes through a set curriculum which varies very slightly from department to department. Every Saturday morning all the apprentices , who are divided into two separate classes (advanced and junior) have a lecture by heads of various departments. This lasts about an hour, and the reminder of the time is reckoned to be filled by the writing-up of notes on the subject-matter. Then when each department heads has had his say on his particular subject an examination is given on a Saturday morning, and then after a week or two the scheme starts all over again, and so we go on. Every three months a report is sent to the parents on the boy's progress, and after about two or two and a half years we make a point of asking each boy whether he would prefer to specialise in any one subject. A number usually

have something fairly definite in view by that time, but we find that sometimes the view that they have formed by then is not their original view. If the boy wishes to specialise on that subject provided his parents are agreeable, we then as far as possible, transfer him to that particular department and for the remainder of his apprenticeship he specialises on that subject. That briefly represents our method, and we are finding it reasonably satisfactory.

On the question of psychology, I was interested to hear Mr. Fleming's remarks, and I gather that in general he has his own methods and does not resort to cut-and-dried methods by outside people. I think he would probably agree, although I have no experience of it, that with smaller firms in particular it would be possible to get the co-operation of such a body as the Institute of Industrial Psychology with the idea of formulating satisfactory tests for the recruitment of craftsmen into industry. I would also like to know whether Mr. Fleming attaches much importance to the question of teachers' reports. So far I have not been able to rely very much on such reports.

I was also interested to hear Mr. Fleming's remarks on training other than technical. Nowadays we get so much technical education that it is very nice to hear that some attempt is being made to train these boys in the other characteristics of life. There are certain things such as fellowship, loyalty, friendliness and so on, that cannot be subject to a laboratory test, and I do feel that in this consideration of technical education we should not neglect the broader aspect of the situation. I would like to know whether Mr. Fleming could throw any further light on the matter of getting suitable teachers. In the case of the smaller firms it is a difficult matter, and we sometimes have to make people instructors who are not particularly qualified for the job.

There is a saying that "the labourer is worthy of his hire" and I feel that the question of a shortage of craftsmen is very much bound up with the lack of financial incentive in the engineering industry. Many parents have asked me whether it is worth while apprenticing a boy for a number of years at a very low wage when his subsequent wage would be so inadequate. We, as production engineers, are becoming accustomed to dealing with low and medium grade labour because high grade labour has not been attracted to the shops, and I am afraid that the recruitment and training of an adequate supply of craftsmen is very intimately bound up with the financial aspect.

MR. FLEMING: Mr. Puckey's contribution is most valuable, but I feel confirmed in my decision not to cover that ground in my remarks. He is at any rate giving a lead to those concerns who may ordinarily not consider that they are either big enough to

tackle the problem seriously or that they prefer to poach on the preserves, as it were, of other people who do train their men.

Regarding the choosing of suitable teachers, this is a matter of "cut and try." I know of no means of selecting, but the guiding principle in our case was to draw on a group of men who had all the equipment both from engineering practice and practice in the trades, with technical knowledge and skill, and a desire to teach and interest in boys. We were fairly fortunate. On the question of the work of training apprentices or teaching them outside their everyday existence, I was glad to hear Mr. Puckey speak of that because we attach very great importance to it.

As to psychological methods of selection, where the smaller firms cannot arrange conveniently to set up an elaborate scheme I should think that the Institute of Industrial Psychology would be a good place to try. I have to speak guardedly because I am a member of the Council. Frankly, I think one has still to look at the problem of selection by psychological methods a little warily. Rather than nothing, I would certainly use that method. If I could use the method of interview and examination by really long experienced people I still believe that that method is the better one, but at the same time it is a very desirable thing to have psychological methods tried. The more experience that can be got and the more firms that will try these methods, so that we can get experience over a period of years, the sooner we shall really be able to evaluate that system and method.

I want just to correct possibly a misconception in regard to my saying that boys who have done well in the examinations do well in the trade. I had to make a reservation, but that applied to the boys who were coming in from the elementary schools. When one gets to more academically minded boys, there I would be inclined to say that those boys for the most part never intend in their minds to be craftsmen.

Mr. J. Paley Yorke: I am concerned with the production of recruits for engineering and I came prepared to defend the junior technical school to the last ditch if it were necessary, but it has not been necessary because the figures have put the junior technical school in a particularly good light indeed, and I was pleased to see it and to hear Mr. Fleming speak so well of the junior technical school.

I am very much concerned about two or three points which arose out of that. I am alarmed because I should not know how to pick out the boys he wanted. Those boys who are good on the machines and in the workshops are the boys who are good on what I suppose is meant by the academic side—in other words they are good all round—in other words they can use their brains, and I presume that you want your craftsman to use his brains. I should find an

extraordinary difficulty in finding the kind of boy he wants me to give him. In showing the promotion charts Mr. Fleming told us that these junior technical school boys were being promoted too quickly, and then I asked myself, "Are we over-producing on the junior technical side?" That of course is a very important matter indeed—very important because at this stage in educational development the tendency is all for more technical schools and not fewer and I am a member of an important committee which is considering that whole question. I am very anxious indeed to hear if there is any possibility of our over-producing in our junior technical schools.

In these schools we do not release our boys until they are just over sixteen, and we do have difficulty at times in placing them because, for some extraordinary reason, employers sometimes take the view that if the boy has passed sixteen he cannot possibly enter into engineering, and I do wonder whether a scheme cannot be devised whereby some remission of the apprenticeship should not be allowed to boys who have had a course of approved training—approved by the Employers' Federation—in a junior technical school.

MR. FLEMING: I appreciate very much Mr. Paley Yorke's remarks. Would he put himself in my position? We are employing many thousands of people to provide five years hence, say, a flow of about 150 men coming out of their apprenticeship at that time, graded pretty well into twelve trades, having made some sort of a shot at what the demands will be in that trade at that time. It is a forecast that with good luck you can make a good shot at. I have also to bear in mind that I cannot afford to train more than 700 or 800 boys because I cannot train them effectively, so that I cannot arrange to pick from the junior technical school (which is a most excellent source of supply) such a number of men that every one of those 800 decide that they will not stay on the bench at any price, that they have capabilities beyond that, and are going on to something else. If they cannot get promotion with me they will go elsewhere. My responsibility is to ensure that I have that number of men, but I am quite prepared to see that 25 of that 800 boys shall climb upwards into other grades. My problem is one of discrimination. My trouble is: Can I, by some feat of imagination or intuition, pick out of the junior technical school output the type of boy that I believe will be satisfied and love a trade, that he really wants a trade, that he would not take anything else if you could give it to him? That is the type of boy that I must have for 75% of my incoming people. I have got to try to discriminate, and I believe our discrimination has come best from the junior technical school teachers themselves. They have given us the best advice on what they think would be the type of boy,

and I would prefer to go by that, coupled with the probationary period of training, to settle that particular problem. As to whether the output is too great, I would not like to say. Personally I think that there is room for a vast amount of development still in the junior technical school output. As far as I know in the North there has been no difficulty in the output being absorbed very readily, and, as I say, our tendency is to lean more heavily on that particular branch with that discrimination that I have described.

MR. OAKLEY : It seems to me that the reason that there is such greatly improved labour after five or six years' apprenticeship over that of twenty-five years ago is due firstly to the better education available generally in this country. Not only have the technical schools developed very fast during the last few years, but our elementary schools have been placed on a far better standing than they had in those days. There are also the highly concentrated efforts which Mr. Fleming's firm, through himself, and his staff, have been able to take advantage of, and those boys are in an environment which, coupled with the better education, puts them on to a higher footing than the boys of the elementary schools in London and districts where there is little or no opportunity of organising on any large scale.

Talking about London and its districts, it appears to me that there is a desire on the part of all engineers and all good thinking employers, to develop this craftsmanship, which our lecturer has so well explained to us, in spite of the specialisation of mass-production methods with which we are now contending, especially in London and districts. Mr. Fleming's works have proved beyond doubt that it has paid them time and again for the concentrated efforts which they have made. I would also like to ask Mr. Fleming, that in view of the great effort made on behalf of the boys and of the development of craftsmanship in his particular industry, the financial aspect has ever been discussed and whether that matter was thought out in the light of the financial point of view. Many of the employers in London and elsewhere in the country still have that idea of how much they are going to get out of their business at the end of the year. They do not worry as to how these boys are trained. They have got to get the best they can, and if we get boys from the technical schools, who are developing not only technical knowledge, but also placing the boy on to a higher moral and social plane than the elementary schools, it puts these boys on a spirit of initiative, which enables them to put their very best into their work, with the result that the employers get the benefit of it. It is not always through the employers' efforts that they are useful tradesmen or craftsmen, it is simply that the lads have had to plod their own way through. Many London employers could do a good

deal more than they are doing at present to improve the boys who have entered their industry. Employers, particularly in small works, might co-operate more in the development of craftsmanship.

MR. FLEMING : The financial question. I do not think that we have ever considered this question of training in the light specifically of a financial venture. The character of our business makes it essential that we should have the very best work put into our plant that we can. That is not because merely of prestige : to a great extent reliability in the case of very big units of electrical plant depends on the workmanship that is put into them. It is an insurance policy to have the very best craftsmanship we can put into the job, and that in itself would be a sufficient justification for going to almost any extent that we thought possible to improve our training facilities. We have groped about a great deal, as you must have gathered from my remarks, in trying to arrive at what we thought would be a satisfactory thing. But beyond that point there is another more important aspect, and that is that broadly speaking surely it must be to any concern's advantage to have the best workmen it can get and it is equally advantageous from the point of view of the worker himself to be as well trained as possible. His training is his insurance against unemployment, and added to that it is, as I say, to my mind a point of importance in citizenship. It should be the duty of employers even from the point of view of their standing as good citizens to improve as far as they are able their employees' training and work.

On the question of the position you find in London. I do not know your problem well enough, but one fundamental thing that would seem to me to be of importance would be to preach, in season and out of season, this point of urging those people in manufacturing firms who are in the positions of exerting influence on employment and the character and quality of employment, the importance of giving attention to this important problem.

MR. G. THOMPSON : The solution of our difficulties in London would be a greater adoption of a part-time system of education. This particular feature has not taken root at all in London to the same extent that it has in the provinces. In many large towns in the provinces the employer releases his apprentice for one day a week, and in addition to that the apprentice puts in one or two evenings per week out of his own time. By that means the training of the craftsman is insured. It seems to me that it is not so much the employee who needs attention in London but the employer.

MR. C. B. NORTHEY : I rise to be shot at from both sides as I am one of those individuals referred to by Mr. Puckey, the teachers, and also in industry am a production engineer troubled with the same problems as yourselves. It has struck me throughout that we are rather going round the question because we shall never

reach the stage that Metro-Vicks have at Manchester. I know the school, have visited it and I can say very definitely that undoubtedly it is one of the finest in the country, but in London, the suburbs, and the smaller provincial cities the problem is altogether a different one. In London and the smaller places we have large numbers of small works. We are also supplying to the mechanised industries the necessary maintenance mechanics. The training ground of the maintenance mechanics, we must remember, is in the majority of cases, the production engineering departments. Mr. Fleming referred to the better material from elementary schools and he met with certain opposition. It appears to me that the opposition failed to consider the problem from the wider angle. On the primary side for years now we have been training for scholarships in secondary and junior technical schools. Many hundreds of our primary school children cannot get to the secondary or junior technical school owing to insufficient places. Considering this it is only reasonable to not only assume but to definitely deduce that the product of the elementary school is on the average a higher standard than in the day when we went to the elementary school. I think this is actually a fact. Mr. Ferguson raised the question of the leaving certificate and there, as a production engineer, I do feel that we as an institution might press upon the Engineering Employers' Federation the importance of their members developing this scheme.

MR. SEYMOUR: The firm I am connected with are trying to wrestle with some of the problems raised by Mr. Fleming, and they are, as it were, bridging the gap between the German attitude and the English one. We have approached the point of psychological selection from this point of view which was brought out by Mr. Fleming, that the Englishman when he is interviewing weighs up the individual as a whole. He looks to the whole person. Previous psychological tests have taken a bit here and a bit there. That may be easier perhaps with a different mentality. You may get that mentality in Germany, but we are endeavouring to approach it from the whole point of view. At the same time we are trying to examine our tests to see what they are testing, which has been another difficulty.

MR. FLEMING: I appreciate that point because some time last year I was in the United States and I have watched the method of approach there in the selection of people without resorting to the conventional methods adopted by the psychologists, and the line that you suggest is very much on the same idea that I found adopted there with a good deal of success by a concern of some magnitude. I have not any experience other than the method of interviewing which we use, which, as you say, is one which is common to our mentality, to try to look at the case of the applicant

as a whole rather than to strive to analyse him too finely and assess rating values to the different parts. That is the risk, I think, and I should be very interested indeed to know what experience you got. Every one of these methods is worth trying. The wider one can extend the methods of attack on occasions such as these the more we can advance. I can at least commend the attempt you are making.

On the motion of MR. G. H. HALES a hearty vote of thanks to Mr. Fleming was adopted.

Discussion, Birmingham Section.

MR. W. G. GROOCOCK: I should like to approach this subject from the point of view of the memorandum and in the same order. While I do not think that Mr. Fleming has read that memorandum he has in his paper followed it very closely and, incidentally, has answered several of the questions contained in it. First, he has told us that craftsmen are necessary, because, if I read aright, he has indicated that they are attempting to make craftsmen at the rate of 1% per year of the number of their skilled employees. While it may be claimed that for the lecturer's firm there is more need for craftsmen than for many other firms, I believe that if examined closely we should find no real difference. Each want craftsmen and below these, others in order of skill, the only point of difference between any firm being the proportion of craftsmen. We can, therefore, I think, agree that craftsmen are necessary.

How we are to obtain these craftsmen has been clearly indicated by Mr. Fleming, and our own common sense, I think, tells us to work along similar lines. The old saying, "If you want a job done, do it yourself," applies in this question of the training of craftsmen, and I am satisfied that all firms should be making efforts in this direction.

Each type of work has its own problem and requires a somewhat different type of craftsman. For this reason alone each firm must take some hand in the training of the type of craftsman they want. Some of the newer firms started of late years have not yet possibly had an opportunity to move in this direction, but quite a number of them have had time but have not had the necessary foresight.

One question I would like to ask Mr. Fleming is, is there any variation in the number of apprentices admitted to their scheme from year to year? Is any notice taken of the volume of trade expected? This is a point where, in my view, firms engaged in any kind of industry should look sufficiently ahead and be able to appreciate that at the end of the next year, or possibly the following year, they will want more craftsmen, and ought to do something in training them. We know that craftsmen will not be made in that short time, and, in fact, we realise that the training outlined by Mr. Fleming would not make a craftsman. We do not expect craftsmanship at twenty-one, but if they have had the necessary training, then craftsmanship, which is a speciality, will develop in time.

I was very glad that Mr. Fleming dealt with the works' school, because in this respect he has answered a number of points that were raised in the memorandum. While schools are necessary in

the larger organisations, it is what is taught in those schools that is the determining factor as to the value of the training.

Our technical schools are doing extraordinarily good work, but, in the main, the training which lads receive at technical schools tends to put them more into the class of technicians than craftsmen. I, personally, would like to see a very much stronger leaning in our technical school work towards the old trade class of twenty years ago or more, when boys were taught fundamentals of a particular line of work, and where those boys who had no mathematical leanings did not feel seriously at a loss. Such boys to-day, when they have to study at the side of boys having a mathematically inclined mind, feel so lost that it puts them right off technical work. The great bulk of lads who will make the best craftsmen have no strong leanings towards mathematics. This means that our technical training must definitely go along two parallel lines, that is, one for the training of technicians and the other for the training necessary for craftsmanship.

There was another point in the lecturer's address on which I would like him to give further information. I am not quite clear whether they take boys into the works in the ordinary way and then select them at a later date for craftsmanship training. For instance, if they take a boy of fourteen, will they select him at fifteen or sixteen and give him an opportunity of an apprenticeship scheme then? There is, to my mind, a great advantage in having youngsters in this way and having the first year or two to study their possibilities. Sometimes, however, it is difficult to do this.

I have, personally, been extremely interested in the course of training that Mr. Fleming has outlined. My own company have something very similar and we divide lads into various courses, such as trade course; drawing office course; and engineering course. There is in our scheme too a possibility of the brighter lads passing into the higher courses according to their educational qualifications.

The last point in the memorandum has not been dealt with. This is, "Can we, as an institution, put forward any proposals for the training of craftsmen?" I believe, when we have put sufficient thought into this matter, and particularly after we have had the result of this series of lectures and the discussions that will follow, we may find it possible to draw up something which will get us one step further towards a definite scheme of craftsmanship training.

There is, however, amongst people who are closely in touch with conditions a definite thought that before we can cut out the shortage of craftsmen something must be done to raise the status of such. When we have trained lads, say, as toolmakers, and have made them into real craftsmen, we certainly ought to pay them something more than we pay a dustman. This is one of the things that must

be altered, but, personally, I do not know how it can be brought about. I am merely suggesting that alteration is necessary, and if we want real craftsmen we must make their standard of life a little higher than it is to-day. Many men in the craftsmen's class have gone into unskilled work simply because there they can earn more money. I believe, therefore, that when we are considering the training of craftsmen we must keep in mind all the time this question of remuneration.

MR. FLEMING: I appreciate very much Mr. Groocock's remarks, and particularly the opinions he has given us out of the wealth of his experience. Going backwards through the points he raised, the importance of the status of the craftsman was mentioned, and I think he put his finger right on the crux of the matter. It is a question of raising that status both in so far as the dignity of his job goes, and the financial return. The craftsman has perhaps something of an insurance against unemployment which his skill gives him, which the semi-skilled man and the garbage collector has not got. Quite apart from that, I agree that the problem should be brought to some sort of practical solution. Another point Mr. Groocock raised was the too high percentage of men who come from the ranks to the commission ranks, to use the army simile. I mentioned that many years ago I made the mistake of selecting too many better-educated boys for our Trade Apprenticeship Course, but after the deplorably low standard of material we had been getting, to find ourselves in a position to select much better educated material, we just fell into it, and for a while we did not know what to do with the young men who came through our apprenticeship courses! It would have been all right if we could have made them all foremen, or draughtsmen.

I need not stress the importance of some scientific method of selection. I must confess that I do not yet see any very great benefit from the psychological method of selection. I think one has to use such methods with a great deal of discrimination and care, but it is a direction that is well worth consideration. I should be interested in any method which would give us some exact way of determining those boys who have mechanical dexterity—that mechanical sense which the craftsman has, and also that creative instinct, and pride in doing a really good job. That is, to my mind, the most important problem in this selection business.

On the question of the age at which one discriminates, we have been prepared to admit boys to the works at the school-leaving age, fourteen-plus, and up to sixteen or even a year over. I do not know if there is any feeling in this district on the part of employers of labour that a boy should not be admitted to a trade or craft after sixteen. There is a sort of negative rule in our district that that is so, but our relationship with our workpeople is so

good—and the education staff get a great deal of help from leading workmen in this question—that we have never experienced any difficulty; if a boy is promising, we consider him favourably. When a boy starts at fourteen-plus, we make a point of having him about the factory for at least a year before we begin to consider his selection for a trade. We try to give him every possible chance to make up his mind for himself. Then again, having made up his mind, we put him on probation for a short time, say three months, before we actually have him sign a binding form. Sometimes this period of probation is extended. Generally when a boy comes in at fourteen-plus, by the time he is fifteen or fifteen and a half, he is launched on a trade. We have not found many misfits as far as I know, but I agree with Mr. Groocock that it is a most important point. In the old days, I used to come across young men who at the age of nineteen or twenty were not at all happy in the work they had taken up, and it was, I think, due to the fact that they had got into the wrong groove, but were inarticulate about it.

Then there is the point of the function of the technical school as distinct from the works school. In the works school we give instruction in the trades as distinct from technical instruction. In this country a very large number of students receive technical instruction, but only a small select group carry it to the stage at which it becomes of practical advantage to them in rising from the bench. In the case of the others, the instruction may have broadened their knowledge, but at the same time it tends to make them discontented with bench work; and they have not acquired sufficient technical education to undertake work of a more technical character.

On the question as to whether one can forecast from time to time the future outlet for apprentices, we expect to have 110 apprentices come to maturity each year, and make a rigid rule that when they have been trained we employ them; we do not let a boy go when he has been completely trained because conditions are slack. It is a very difficult job indeed to forecast future requirements over a period of years. We have only been able to guess at it from past experience, but in the last few years we have not gone seriously wrong. Immediately there seems to be a prospect of a change in conditions, for instance the change that has occurred this last year, we either bring in young men towards the upper age limit, sixteen rather than fourteen, or we may select young men who started as handy youths, and, if they show promise of doing well, bring them over into the course so as to give us a little more flexibility in filling the gap.

There was one point I should like to have made, namely, that I think this problem of training young people is more than a matter for individual firms or for industries—it is a national concern.

The most important asset we have in the country is the personnel. If, by better training, we can improve the capacity, not merely in output, but in skill and quality of their work, we are improving a national asset. After all, we spend a lot of money on plant and tools which depreciate, but in personnel we have an appreciating asset. We do not very often look at it in that way. As Mr. Groocock points out, newly-established industries or works have not the facilities for dealing with this problem of training that the large concern has. I think it is the responsibility of the large concern to take a broad view of the situation, and train to its capacity, even if it loses some of its trainees to concerns who do not train for themselves. Nationally it is a good thing.

Regarding the point Mr. Groocock raised on the percentage of apprentices, I spoke of 11,000 people in the works. I ought to have pointed out that this included 3,000 staff, and if you take out also 1,500 women and certain other trainees this will bring the proportion of male employees in the works down to something in the order of 6,000.

Mr. A. W. Field: I do not think too much emphasis can be laid upon the crux of the matter pointed out by Mr. Groocock and Mr. Fleming. I have a shrewd suspicion that the Institution, when they put forward this subject for discussion, had in mind not so much the training of craftsmen as the scarcity of skilled craftsmen to-day, which is likely to be still greater, and what to do to get them. I think they realise that their training can well be left in such skilled hands as Mr. Fleming's, and men holding similar posts in the large industries.

I do think they have not got over the difficulty of tempting the right material into the job, and undoubtedly the crux of the matter is the wages problem. It seems rather a senseless idea to expect craftsmen in industry to rank with third-rate members of the population whose educational attainments are no higher than the elementary schools, and get no further than operatives in industry.

I think Mr. Fleming and Mr. Groocock may both be looking at it from the attitude of the large firm, in which there is a certain amount of stability, and where the skilled craftsmen are pretty well the main producers of work coming through the shops, but we here in Birmingham know there are not many firms whose business warrants the employment of many skilled men—certainly not so many that they can be trained in the manner outlined by the lecturer. The census of firms will give you figures. Less than 2% of the firms have more than 500 employees; less than 2% therefore can really train their own skilled craftsmen, and that is why a good many of the trained men from the large firms go into other industries. If these smaller firms are going to be able to get skilled craftsmen,

they will ultimately have to establish a status worthy of craftsmen, a status which they had when industrial production was being built up during the last fifty years. That, of course, will depend mostly on the wages offered to them, and one would like to have the ideas of some such authority as Mr. Fleming as to what is the standard of life a craftsman ought to be offered to make him feel it is worth while.

MR. FLEMING: I am going to sidestep Mr. Field's last question. I would not like to venture to reply to it, though if I were speaking as a craftsman, I should put it very high! It is just a question of which end of the telescope you are looking through. I agree with him as to the importance of the question of status. His remarks did raise in my mind the point as to whether in the small concerns, it would be possible to do something collectively. As he points out, the percentage of concerns having a sufficient number of workmen to justify a conventional training scheme is small but I have been wondering if it would not be possible for a number of small concerns to undertake collectively some form of training. Just to take a parallel case in the training of the technical apprentices in the electrical industry, young men who come in from the universities and spend a certain period of time, perhaps one or two years, in the shops, and then take up staff positions. Some years ago, a scheme was put forward to the British Electrical and Allied Manufacturers' Association whereby we should group together a number of specialist firms, none of which were able to give a complete training, to arrange collectively to take some of these young men for perhaps six months; for instance, they should have six months with a firm making instruments, six months with a firm making switchgear, and so on. I do not know whether anything of the sort would be possible in a collective way so as to utilise some of the facilities that do not permit of complete training, and also more particularly to utilise the great experience that the manufacturers in these small concerns must have.

MR. F. PEARSON: Referring to the question of engineering instruction, I should like to read the concluding paragraph from a report issued in 1920 when a very representative committee was appointed to investigate education for the engineering industry: "There is practically no demand from our witnesses for school instruction aimed particularly at the development of manual skill in crafts. The opinion is generally expressed that this can only be learned in the shops."

I am personally concerned with a small shop, and as mentioned by an earlier speaker, it is to the small shop that this Institution may give some help. Why should not we have the same type of instructor as our lecturer has in his work classes in the Central Technical College in Birmingham? Another point I would like

some help on is the grading of craftsmen. I feel that, as the future shows itself, we shall get a better type of lad coming in from the shop, and from the elementary or secondary schools, and I am wondering how far this craftsman idea will be looked upon as a general thing, rather than as a training, if there is no grading in craftsmanship. I have the patternmaker in mind, the sort of man who needs nobody to tell him how to make his patterns. Are we going to grade that craftsman together with the craftsman who would not require the knowledge, experience, and ability of the pattern-maker? I think we ought not to lose sight of the difference in craftsmen.

Another point is, the university graduate working together with the man who has worked his way up in the shop, coupled with a fair amount of slogging at home. Are you going to mix these two together so easily as the lecturer suggested? I mean the type of man who has grown up in the shop and, by his very long experience, has been able to show that he can demonstrate his capabilities, and also organise the shop. Do I understand Mr. Fleming to say that the young man who comes from the university is the man who will be, from the very start, considered as the future executive man in the concern? I am just a bit anxious on that point. During the past few years, some large factories have reached a stage where it has been necessary to bring in specialists, and, needless to say, some of the old-time foremen have not been able to understand the need for these. While everything has been very nice on the surface, I am wondering whether there are not rumblings underneath. The point I am pressing is this, are we acknowledging the old craftsman when he has reached that stage of authority? Probably we have found him important in the works; are we helping him to deal with the man who is coming in? It is important, because, unless we can bring these two people to work amicably together, I think there may be a crash.

MR. FLEMING: Dealing with the point Mr. Pearson has raised—which is a very important one—about the university man coming into the shop, I should just like to tell him what happened to me some years ago, at a time when conditions were not too good in the shops. We had occasion to appoint two men who had come in from the university to what we call a shop engineer's job. It was really a job assisting the superintendent on certain technical work. One of the leading shop stewards came to me and said in quite a kindly way (we were always very friendly about these matters): "I do not think it is right. A job of that kind should be for someone of our own class." We looked up the records of the two men concerned. One of them was the son of an artisan who had started at a primary school but had won scholarships carrying him through to the university. The other man came from wealthy parents and

had attended a first-class public school and university. Both had been selected on merit. Both had come in through exactly the same channel and satisfied the same requirements; both apparently were quite good material, but of different types; both had parallel jobs. This is an instance which shows that a boy can rise no matter what his beginnings. A boy who starts on the craftsman's side can, provided he equips himself technically through part-time study, force his way to recognition for the highest posts. I must emphasise, however, that that kind of thing can happen only in the comparatively large concern. I think that, if, as is the case in my organisation, the guiding principle is that a man rises on merit, and any position is open to him if he has the ability, no matter from what source he came in, the difficulty Mr. Pearson mentioned is ruled out.

On the question of grading craftsmen, Mr. Pearson raises a very interesting point. For many years I have insisted on our boys, during their apprenticeship, being examined by means of practical tests set by the foremen and instructors, or members of the educational staff, these tests taking the form of pieces of regular work going through the shop. I have always had in mind that we might establish some system whereby there would be some kind of grading of ability. While I do not want to suggest that we need always look at other countries, least of all, Russia, I have been in Russia a good deal, and have myself carefully studied the system there, especially as it applies to education and research. Four or five years ago the plan there was to establish a dead level of ability, but in two years the whole idea changed and trained workmen were graded according to ability. Just how far that can go, and it does not mean quite the same in Russia, perhaps, as it does in this country, I do not know.

MR. D. A. HANNAY: For about eighteen months I have been serving on a committee which has been discussing this subject of training, chiefly with reference to the training of apprentices to obtain craftsmen. We have approached most of the technical schools in the town, and have also approached a number of technical societies. They are all very sympathetic, and agree that there ought to be some universal scheme for the training of apprentices. We have asked them if they could put forward any concrete and practical suggestions for a scheme of this nature, which could be universally adopted. We have also approached a number of employers. They are sympathetic, but admit that a stumbling block from the manufacturer's point of view is the economic side of the question.

I have come to the conclusion, though the report has not yet been submitted, that a scheme of universal training of apprentices, chiefly with reference to craftsmen, is not practicable unless it has Government support, and would suggest that the Ministry of

Labour offers an organisation at the present time capable of undertaking this work.

MR. THOMPSON : I should like to congratulate the lecturer on the way he has covered his subject. One point he brought out very clearly was the value of technical education to industry. The lecturer's firm has succeeded where many others have failed, that is, in giving satisfactory training to apprentices in the works itself. In Birmingham and district, which is for the greater part a city of small businesses, such a method would be both costly and inefficient, and so the trade must look to the technical colleges for aid. One speaker inferred that craft teaching in technical colleges was impracticable. With this idea I emphatically disagree. There is no more difficulty in training trade or craft apprentices in their practical work than in their theoretical work, given the necessary apparatus and machinery. This machinery is expensive and has a relatively short life. The method adopted of financing education is such that no fund can be accumulated to allow for the depreciation of machinery, any unspent balance of the yearly grant being returned to general account at the end of the financial year. An equitable method of satisfying the requirements of the college would be for the trade to provide the necessary equipment on permanent loan keeping it up to date and replacing it when it becomes obsolete. If some such system was adopted, teaching would be easy and could be taken to any standard desired. I am satisfied that it could be done at least as well as in the works. In a works school, however good, there must always be a leaning towards specialist rather than general training which is to the disadvantage of the apprentice and also, in the long run, to that of the employer.

MR. FLEMING : I would hesitate to enter into any discussion on the merits of technical schools for trade teaching and schools in works. Both have advantages, both disadvantages. The teaching in the works school may lack the skill of the teacher, because the teachers are chosen for reasons other than teaching ability solely. On the other hand, you have the incomparable advantage of the teacher knowing precisely the boys' everyday work, and the difficulties he has to overcome. He can illustrate points in his school teaching by means of work actually in the shops ; also he is able to bring the particular refinements of that teaching into line with actual practice in the shop. In the technical school, you have to take the greatest common denominator for different peoples from different industries.

I was interested in Mr. Thompson's remarks on the psychological tests made some years ago. I should really like to know what became of the boys themselves. Another point, mentioned by the last speaker before Mr. Thompson, was the question of Government support. This is one of those things one approaches with some

trepidation. Government support has its merits and disadvantages, but I appreciate very much the difficulties of the smaller concerns, with their diversity of kinds of industry, as is the case in this city. Where the concern is big enough, I would personally try to get along without Government support, but it is a matter of taking the case on its merits.

MR. R. H. YOUNGASH : The question of apprentices is probably nearly as old as the human race. We are told, amongst other things, that even so far back as the building of King Solomon's temple, there were apprentices, and as we come nearer to our own times, we can visualise that at one time boys were apprenticed to smiths' work, stonemasons' work, and woodwork, as occupations with which they could interest themselves for the rest of their lives, but to-day few boys will be content with such a narrow outlook.

One can, of course, discuss where the craftsman ends and the technician begins. It is an extremely difficult problem, because we are talking to-night of training men for craftsmanship, and in the same breath are talking about sending them to technical schools in order to get that training. While I quite agree that the two cannot be entirely divorced, the moment a man becomes a technician the impression is that he ceases to be a craftsman.

There are two reasons, so far as I understand the position, for boys becoming apprentices. One is that, in times of scarcity of employment, as Mr. Fleming has already indicated, he has more chance of keeping his job ; the second is that in times of plenty there is usually good money to be obtained at it. I think these are the primary reasons to-day. I do not think, personally, that there are any but a very small percentage of boys who become apprentices to any trade because of a peculiar and direct regard for that particular trade. I may be wrong, but that is my impression, so far as it affects engineering.

The subject we are all interested in to-night is the trade apprentice, that is, as Mr. Fleming has outlined, fitting, turning, and machining operators. The first question one has to ask, it seems to me, is what type or grade of individual is there who is likely to be trained for this trade ? Is it not a fact that many boys become interested or engaged in making engineering operations more by default than by selection ? There are instances where certain peculiar conditions obtain in certain districts, but in a town with such a diversity of occupations as Birmingham, boys rather drift into the different trades than set out deliberately to become mechanics or craftsmen. Having, for one reason or another, entered the shop, they then begin to consider the question of technical training, and probably their firm, or someone engaged in that works, says : " It would be better if you go to the night-school," and this they do. But surely the average boy who comes from the secondary school, or

junior technical school, is looking for something very much better in this world than to be a mere mechanic !

There is another question. What percentage of the individuals we meet with in the ordinary run of factory operations have not served an apprenticeship but are equally as good, so far as being mechanics is concerned, as the boys who have served apprenticeships ? What particular advantage is there in having passed through the apprenticeship, from the apprentice's point of view ? One can understand this question from the employer's viewpoint. He is desirous of maintaining a steady source of labour. From the apprentice's point of view, in this district at any rate, there is nothing to choose between being a trade apprentice, whether he has paid a premium or not, and a boy who has not been trained. Again, what are the particular advantages that this training offers individual firms as against the ordinary method of engaging labour in the normal way ? There may be many districts where the labour is not so plentiful as it is in Birmingham. There may be some reasons why there is a peculiar difficulty which in itself provides a reason for adopting some scheme of training apprentices, but in towns such as Birmingham there does not seem to be any real incentive. If that is so, then the question has not the vital importance that one might presume it had, on looking at it from the point of view of a man not so fortunately placed, and that opens up the question as to whether there is any real necessity for our technical schools to spend their time in training such labour. Would they not be better occupied in teaching the men of the future their own particular business ; doing it thoroughly, and maintaining the supply of technicians and higher executives who are not so easy to get as the lower grades ?

Mr. Groocock rightly said that the technical schools provide technicians, and technicians do not want to be craftsmen. My own view of the situation is that in modern works roughly 50% of the employees must have some technical knowledge, and the proportion of skilled craftsmen is something in the neighbourhood of 15-20%.

That 15-20% is not difficult to obtain because to-day we have divided and sub-divided our highly skilled operations up to such a degree that one can scarcely bring to mind an instance where a man is required to exercise skill such as craftsmen were expected to exercise thirty years ago, when we took a fitter, gave him a sketch or pattern, and he had to take a piece of steel, forge it into shape, plane or shape it, file it, and, if necessary, put it into the place it had to occupy in the machine. That does not obtain to-day. Operations have been so divided that what we want to do is to train our men for a comparatively narrow range, and, if that is so, I feel that the shops themselves are best qualified to do that particular work. Personally, I think, and I have said it many times before, that

there is no superior alternative to a properly arranged workshop training school.

With regard to the small shop, there should not be any difficulty about that; it is only a question of method. One need not necessarily set a building apart, though if it can be done, it is better to do so, but it could certainly be attempted, and a good deal of work done, by setting certain individuals to supervise the operations. There is one particular difficulty, if you put those boys in the charge of a good craftsman, they will learn little, because a good craftsman rarely possesses (or only to a slight degree) executive ability. Executive ability is more particularly necessary with regard to training boys than any other qualification I know of, apart from it, technical knowledge in itself is of very little use. If you are going to have a workshop school, you will have to get men of the right type, with executive ability, as instructors.

You may have to go to your technical schools to get those men, but it will have to be done.

There was one other point to which I would like to refer, that of medical examination. I believe that is a feature which is seriously neglected, and that not only so far as apprentices are concerned. I believe it would well repay every manufacturer in this country to institute a proper medical examination of his employees. How far that is possible, I do not know, but so far as apprentices are concerned, I am sure it would be well worth doing.

MR. FLEMING: Some of the points raised by Mr. Youngash are very controversial. One which struck me was that there is, perhaps, a risk of our confusing the training relating to the production of means of producing commodities, as compared with the production of consumable commodities. If, for example, we are making a turbine, then we are producing something which, in itself, is going to assist in producing commodities, because it affords power which can be used in all kinds of mass production factories. In production of this kind we require a far greater density of craftsmen, and far less sharp divisions of employment between the craftsman and the specialist, than we get in the trades producing consumer goods. If Mr. Youngash will accept that broad distinction, then a great many of the controversial points he has raised, while they will certainly obtain in that field, will not do so with the same force as when dealing with people trained in producing the consumable type of goods. You cannot put turbines on mass production. You have got to consider each class of work almost by itself, and there you have the possibility of individual skill and individual creative effort coming in. *That* man has been trained to do that job, and he is turning out work that will eventually go towards maintaining light or power in the city. There is something that appeals to his

imagination that does not apply in the same way if he is employed on highly skilled, but purely specialist mass production work.

One point Mr. Youngash raised was, whether it is worth while being an apprentice. Apart from the question of security of employment, there is a good deal more in it than one might be inclined to judge from his remarks. I can only say here that in my experience of my own particular concern, we can almost, in walking through the shops, pick out the people who have been trained in our own place as compared with people coming in from outside. I am not quite so despondent about the idea expressed by Mr. Youngash that a man hardly ever takes up a trade or craft because he really likes it. I am quite prepared to admit there are a very large number who take up a trade solely as a means of making a living, but I would say that quite a big percentage do it, in my experience, because they like it. I remember having an instuctor who had been a particularly skilled worker, and who had been put on the instructing staff. He said : " I do miss the thrill I used to get out of producing something, and the skill that I put into the job." I am not quite so despondent.

MR. J. A. HANNAY : I have been looking for many years for young men who could be trained for executive positions, and I have got more or less out of touch with labour in the shop, craftsmen, etcetera, and it is very interesting to hear what Mr. Fleming's firm has done. It might be of interest if I mentioned that of all the firms in this country, 3% employ 50% of the people employed, and the other 97% employ the remaining 50%, so that I think training is going to settle itself fairly quickly. The big combines have got to do something like Mr. Fleming's firm.

As far as the smaller firms are concerned, I do not wish to see them pushed out ; I do not think they could be pushed out, some of them are too vigorous ; but I think we should give all possible support to our technical colleges. It should be possible for a man working in a small shop, learning a certain business, to get more experience and knowledge by going to the technical school, and seeing other machines and getting ideas of the other branches of the industry. In Birmingham, our technical college is doing splendid work, and we ought to support it. If it is possible to get the Government interested to back up the technical institute, I think we ought to do so.

I was delighted to hear the lecturer say that the young men of to-day are better than those of twenty-five years ago. I have come to appreciate that they are, and I am glad to hear somebody in his position say so. I have much pleasure in proposing a sincere vote of thanks to Mr. Fleming.

Communicated.

MR. A. W. FIELD : At the Meeting on December 19th, when Mr. A. P. M. Fleming addressed the Birmingham Section of the Institution on the " Recruitment and Training of Engineering Craftsmen," the writer was able to make some little contribution to the discussion, but was obliged to leave before the meeting closed. The following comments are therefore sent as a further contribution.

In thinking over what the meeting obviously accepted as a very urgent problem—a problem which is already acutely worrying business men in industrial districts—it would seem that in spite of the very excellent method of recruiting and training craftsmen, as built up by Mr. Fleming and his colleagues, no real solution which reaches down to the root of the problem was put forward.

As the writer stressed in his remarks, adequate return or remuneration for the years of training for the skill and intelligence which are expected from skilled craftsmen, constitutes the major portion, if not the whole of the problem. A skilled craftsman can in many ways be likened to a skilled artist who commands large fees for entertaining us, and justifies it because of the extensive training and peculiar skill he possesses.

It was obviously the opinion of the meeting that lack of adequate remuneration has been the cause of the scarcity of skilled craftsmen ; that it cannot be wondered at, and further, there is no excuse for it.

As a means of correcting this, the writer suggests that a sound way of tackling the correction of this is to establish an " Institution of Skilled Craftsmen." This could raise the status of the skilled craftsman to that of a profession, and if membership was made really strict, even more so than that of the present Engineering Institutions (which really provide facilities for meetings and discussions whereas a medical degree or membership of a closed profession guarantees a status), it should be possible to establish a recognised minimum remuneration for its members.

Firms requiring skilled craftsmen, i.e., skilled in the true sense of the word and not workers of single purpose machine tools, would welcome such an Institution and a guarantee of ability and training to some standard which could be offered by the Institution. It would also give to the craftsman to-day what the craftsman in the early years of industrial development had in his Guild. It would further give to the craftsman that merit due to him for his part in industry, and would do much to maintain the superiority of workmanship which always has been the proud boast, and one of the selling factors in English workmanship. Such an Institution

would be a worthy progeny of the Institution of Production Engineers, who could not undertake a better task than that of nurturing it to a ripe age. Whitworth with his scholarships set something of a standard to which it has been possible to work. In spite of all the difficulties that can be envisaged in outlining a broader qualification, and separate qualifications for different crafts, it is not impossible, and the writer recommends this solution to the careful consideration of the Council of the Institution of Production Engineers.

MR. S. E. KUERSCHNER: With reference to Mr. Fleming's most interesting lecture and the following discussion on December 19th, 1934, I should like to say that, in my opinion, the present rather apalling conditions in the recruitment and training of skilled engineering craftsmen could only be overcome by centralised, i.e., government organisation.

Having followed most closely the methods of recruitment and training in its various forms, may I suggest that preliminary examination of the candidate by a Board or Advisory Committee on Juvenile Employment, consisting of prominent educationists, doctors and psychologists, would eliminate wastage of human power and ambition and therefore would ultimately save both time and money.

This Board, types of which have been existing with great success on the Continent for years, should be government controlled and open to anybody for consultation without charge. From a national point of view it is a great asset to be able to direct men towards their natural profession or trade. The advice issued by the Board is not compulsory, and only serves as guidance.,

The training as outlined by Mr. Fleming, but adapted on a national scale, would be to send the apprentice to a workshop school after his first year of apprenticeship. The first year in the school, two half-days weekly, would give a general engineering knowledge to the candidate and therefore no division between the several engineering trades would be necessary. Second school year, two days at school, weekly, division of apprentices according to their profession and trade. For example: turners, millers, etc. (this in smaller towns where the number of apprentices is insufficient, can be brought under heading of machinists) then fitters (different trades), plumbers, carpenters (pattern makers) attend, all in different classes.

Third year and fourth year, continuation of second year programme. At the end of workshop school training a certificate of efficiency is issued. The fourth school year ending, the apprentice

has finished his contract and is, if the school and workshop authorities pronounce a favourable verdict, admitted as a skilled craftsman (first stage).

The young skilled craftsman has to pass two or three further years (according to capabilities) until he is admitted as a full rate craftsman (second stage). This second stage should not be considered as final. Additional experience should enable the talented skilled craftsman to improve his position financially with the years and therefore help him to preserve his trade. When going to school, a close contact between the head of the school and the works' management is essential so as to safeguard a regular attendance at the school by the apprentice.

If a decision relating to classification of skilled craftsmen could be reached, there should be nobody entitled to call himself a skilled craftsman or be engaged as such unless he had served his apprenticeship and is bearer of the foregoing certificates.

I endorse Mr. Fleming's statement, "The craftsman should be given a commission in the ranks of industrial workers."

Discussion, Western Section.

SIR WALTER KENT (President of the Institution) : I have listened with extraordinary interest to this wonderfully complete address Mr. Fleming has given us on a subject of vital concern not only to everyone in the engineering industry in the country but to other industries as well. Most of you have probably felt the dearth of trained skilled men, which is one that threatens to imperil the efficient carrying on of many of our big works. The remedy no doubt lies very largely in the direction indicated by Mr. Fleming. That remedy not only promises to afford an ample supply of those skilled men whom we need so badly, but also to promote that splendid feeling of comradeship which is one of the most vital factors towards efficiency a works may possess.

I have been more interested in Mr. Fleming's lecture, perhaps, from the fact that in a humbler way we have in our own works carried out a somewhat similar system, but, as Mr. Fleming pointed out, the extent to which such an ideal may be implemented must depend to a very great extent on the size of the firm and the number of lads who have to be trained.

All our boys come under the care of our welfare organiser, and it is his job to get them to join our boys' school. That school is carried on only during the winter months, for two nights a week, and for two hours each night, after the works close at 5-30 p.m. The boys are first given a good tea, because to endeavour to pump knowledge into boys suffering from empty stomachs is an extraordinarily difficult operation. They then have two hours work in mechanical drawing, mathematics, elementary physics, etc. Many of the lads are very keen and about 30% join the school and while in the school they are invited to enter into a form of apprenticeship, which most of them, with the consent of their parents, adopt. Then as they get a little older, I forget the exact age, they are given more advanced tuition on Saturday mornings, and they are also invited to join the technical schools and the technical institute, the fees for which we pay. We have now brought these boys up to twenty or twenty-one. Then a consideration comes in which no doubt Mr. Fleming has encountered, but which he did not refer to. That is, one of our great difficulties, the pay of the engineering craftsman, which most of you know, is a matter for grave consideration between the Engineering & Allied Employers' Federation and the A.E.U. Everyone who thinks about it must feel that the craftsmen of the country are not paid an adequate wage if it is measured by the wage paid to, say, the sheltered trades. The higher wage paid to the sheltered trades, not only sets up a very galling and invidious comparison, but by the greater purchasing

power given to the men in the sheltered trades also raises the cost of living to the skilled artisan. Now, we in England, dependent as we are on our export trade for our very existence, if you get down to fundamentals, cannot afford to pay higher wages if we are to compete with the foreigner who is working at a very much lower wage, and in some countries, such as Germany, if further helped by the fact that the manufacturer is paid a percentage, up to 20% upon his export manufactures. I want to make the point that the skilled artisan is entering an occupation that does not seem to offer the same reward as that which may be obtained by people in the sheltered trades who are less skilled. The result is that when these lads we have helped to train come to the age of twenty-one, they hear of some pal of theirs who has got a job as,say,a tram driver,who gets an unskilled job at a higher rate of pay than that which they can obtain by following the occupation for which they have been trained, but that training has rendered the skilled artisan a better instrument for anybody's purpose and naturally he posseses an advantage in applying for such a job over people not so trained, and therefore an appreciable proportion do drift from the work in which they have been trained to other jobs. Therefore one must in a works endeavour to train a a considerably higher number of people than those for which room can be found in ordinary times and in any hoped for extension. That, I feel, is a consideration which cannot be lost sight of. You cannot blame the men. We are all out to do the best we can for ourselves. We have had one happy experience, which no doubt Mr. Fleming has also had. Nearly all the better positions in our works, such as shops superintendents, foremen, etc., are now occupied by people who went through our school as boys, which shows they have fitted themselves by education to take the better jobs that are going.

MR. GAUNT : I must congratulate the lecturer on a very interesting paper. I think the apprenticeship training and selection service outlined a very fine thing. I was surprised to hear that there was surplus labour available in the proportion of 20 : 1. I wonder whether this is partly due to any falling off in trade in the locality, and whether the 20 : 1 surplus has obtained for several years. Possibly the rates of pay in the other industries may have some bearing. With reference to psychology, I think there is a very great future for this. I sent my own boy to the Institute of Industrial Psychology, but was rather surprised when farming was the industry recommended as being the one at which he was most likely to succeed. One other point with regard to schools. I don't quite understand the class of school referred to as central schools as distinct from secondary schools. Perhaps they are peculiar to the north of England.

MR. FLEMING : First, may I just thank Sir Walter Kent for the

way in which he summed up the various points. I appreciate the disparity of pay between the skilled man and the man in the sheltered trades. I believe the craftsman probably gets some satisfaction out of his work, and possibly gets a greater measure of security, but after all that is perhaps not very attractive as compared with a rate of pay. I was most interested to hear him say that in his own works so many of the important positions were filled by men who had been through their school.

With regard to the 20 : 1 ratio, I think the real reason for that was because other firms in the district were not studying their lads as we were and the parents appreciated this. It was also due to some extent to the falling off in the textile trades. Last year's ratio was more nearly 10 : 1. This I think is due to the fact that our standard of requirements is higher. That we get such a relatively wide selection is probably due to our having established a name in the locality, and also that fellows who have come to us have spoken well about our scheme and this has tended to make some attraction.

I was interested to know Mr. Gaunt's experience in regard to psychological selection. I think this is a thing we should all watch with interest. The method is most attractive but I think requires a good deal of further proving. With regard to central schools, these are not confined to the north, but are found in London and other large cities. Children selected from the primary schools enter them at eleven plus, and the curriculum is less extensive and less "academic" than in the secondary schools. In them, children pursue, up to a maximum age of sixteen, courses which look definitely towards commerce and industry rather than towards the professions and the universities.

MR. HERRIOT: I was very interested in Mr. Fleming's paper. As an old Vickers' apprentice I am sorry such a scheme was not instituted in my time. I am afraid I can only think that my parents did not get full value for the money they paid for my apprenticeship. In, I think, the electrical fitters' branch, Mr. Fleming stated that there are 250 apprentices to 300 craftsmen. I should like to know if the apprentice is left to work alone or is definitely attached to a craftsman for training? Has Mr. Fleming had experience of premium and non-premium apprentices working in the same works?

MR. WHITEHEAD: Whilst listening to the way you handle your lads when you get them, the question arose in my mind, don't you think it is too late? Should not the apprenticeship really start at school, and should not the psychologist be sent to the elementary schools for the selection of the future mechanics? You take any boy at the age of five or six. He starts playing with his toys, a steam engine or perhaps a Meccano set. Don't you think that is the time the psychologist should get hold of him. I think the

shortage of mechanics at the present time is due to lack of foresight in education. Don't you think in our elementary schools one or two lessons a week could be given on engineering subjects? You imagine the effect on a lad of seven or eight if he could see, perhaps, a motor car stripped down in his school. Don't you think his mind would be guided towards engineering? If this was done I should think the year or two which is wasted after he leaves school would be cut down. At present boys don't know what they want to do and just drift around for a bit and get jobs as errand boys or such like. Whereas if a psychologist could get hold of them earlier, don't you think those youngsters would definitely know what they wanted, and we should have eventually more craftsmen? I think most boys have a natural bent towards engineering.

MR. GIBSON: How do the starting rates of pay for boys at Metro-Vickers compare with the starting rates of other trades in the locality? I have been investigating this business for some time and three years ago I started a general knowledge test, and I was appalled at the low standard of the boys from the elementary schools.

I think low wages often react owing to home circumstances, as the parents are often compelled to send boys elsewhere where they can earn more. Do you take premium apprentices in your works?

MR. ANDREWS: As superintendent of this college, am I in order in pointing out the fact that we have here both evening classes and part-time day classes for all branches of engineering? I am sure that this is not fully realised by employers and employees in the district, in fact some of your own members have found it necessary to be directed to the college on the occasion of their first visit. If any of you require further information regarding any of our classes I shall be pleased to supply it.

I have three questions to ask the lecturer. Do all your apprentices have equal opportunities to attend part-time day classes or are they selected? Do the apprentices attending classes, take any recognised examinations such as those for National Certificates in Engineering or the examinations of the City and Guilds of London Institute? Would the lecturer kindly give his opinion as to the relative value of part-time day classes as compared with evening classes.

We have in Bristol at the moment three central schools and I understand that a fourth will open in the near future, and from my experience I can vouch for the fact that they turn out some very excellent material. With regard to one speaker's remarks concerning engineering classes in elementary schools, the teachers in elementary schools have more than enough to do if they teach the seven-year-old scholars the elements of reading, writing and arithmetic.

MR. TAYLOR: We have been into the question of the selection of apprentices lately, and the final decision we came to is that your psychologist and school examination are not of very great

importance, and from the troubles we have had in the works, we think it is more important to get people with a sense of discipline. The psychologist may be able to select boys with a bent for a particular kind of work, but if he will measure their " discipline " he will be doing a better work.

MR. HERRIOT : There is one trade that is sadly neglected with regard to training of apprentices, and that is inspection. That is bound to be the opinion of anyone who takes an interest in the American methods of production. It appears that with the advent of semi-mass production and the employment of jigs and fixtures which mean semi-skilled labour (and after all as you bring in jigs and fixtures you do away with the old-time craftsman), the need for inspection is increasing, and I have yet to see any firm in England who set out to train inspectors. I know this is a meeting of production engineers, and perhaps inspectors are not considered necessary to production, but my experience is that you cannot make an inspector in five minutes. You have got to have men who can look ahead and consider what the part is used for, and who know the whole job. It is no good looking round and then saying, " This is a bright lad, he will do for an inspector." Inspectors will definitely have to be trained for the job. People still fail to see the necessity for inspection, but it has got to come and if the matter is not dealt with there is going to be a dearth.

There is another point. When I put my first questions I did not realise that they would not be answered until the end. With regard to the 250 apprentices to 300 craftsmen and whether the apprentices are given jobs of their own to do or are attached to different craftsmen. It would appear to point to cheap labour if the apprentices are given jobs by themselves, but if they are attached to different craftsmen and are gradually working upwards that is a different matter.

With the premium and non-premium apprentices, my experience has been that both classes of apprentices do not get the same training. The premium apprentice gets pushed and the non-premium apprentice is continually kept on the same job, and then you get a feeling of dissatisfaction between the two types creeping in, and I do not think it is possible to employ the two classes together satisfactorily in the same factory.

MR. WILLS : Does the lecturer think this question of the training of craftsmen is a domestic or a national one ? Does not he think the Government should help to train lads in the right way to make them efficient craftsmen, with the latest methods such as a properly equipped school to train them before they come into the works ?

MR. KENWORTHY : There appears to me to be two points that have come out from Mr. Fleming's lecture. The first is that the

tendency seems to be to train apprentices with a view to retaining them in the works in which they are trained when they become tradesmen. This rather upsets the idea of a generation or so ago. At that time when a young fellow had served his apprenticeship and attained the age of twenty-one, he was turned out to get experience in other works and finish his training. The procedure was generally recognised at that time and no doubt had its particular merits. The reason for the present procedure is probably that in these days of more specialised production, once a youth has become experienced in the ways of a particular trade in a particular shop, he is more useful to the firm who has trained him than new men would be, and he becomes a specialised tradesman rather than a craftsman.

The other point is that the tradesman is recruited more from the elementary schools than from schools of a higher education. That brings us to the question: what does the term craftsman mean? Does it means a mechanic who is skilled in a particular branch of a trade, or does it means a man with a general technical and mechanical skill who develops into an executive position? We require all the specialised tradesmen we can get to-day, and these should undoubtedly be recruited from youths who have received nothing more than an elementary school education and who have no aspiration for the higher posts. The training of youths for specialised sections is a comparatively easy matter but it is not on these that the future of the engineering industry depends. This function will devolve on the skilled craftsman who has had a sound technical training followed by an all-round practical experience, who becomes sufficiently competent to undertake executive positions.

One or two speakers referred to the standard of the elementary school boy. At one time I had to interview quite a number of youths and one of the questions I generally asked them was, "How many sixteenths are there in an inch?" It is surprising how few can answer the question straight away. I would like to ask Mr. Fleming: (1) Are his apprentices actually employed on production work? (2) Do they work on piece work or on day work for the whole period of their apprenticeship.

Mr. Higgins: I have given consideration to the problem of craftsmanship, and I believe that craftsmen are no longer required in the shops. A few days ago I was approached by an applicant for a job, and on asking him what he could do I was informed "turning, milling, drilling, grinding, fitting—anything." Now I have no use for men who can do "anything"; I want men who can do "something," and do that something well. In these days of mass production we require men who are expert on one job only, and we have already reached the stage when an operator of a vertical milling

machine is not capable of running a horizontal machine. There is, however, a field for a limited number of craftsmen. I consider that no foreman or superintendent is really capable unless he knows something about the other man's job. It is necessary, therefore, that he should have a smattering of knowledge of patternmaking, foundry work, forging, and the various ramifications of the shop sections if he is to become efficient. To sum up, we need skilled men in the shops, and craftsmen as executives.

MR. ROWBOTHAM: I really think the speaker might have started with a definition of a craftsman. It has been touched on by quite a number of speakers. Really what do we mean by the term craftsman, and do we need in the modern engineering factory or production factory the old-time craftsman? Mr. Higgins mentioned this matter and I think if Mr. Fleming in his reply would give us some definition of a craftsman it would be just as helpful after his lecture as before it.

Well, I am going to be a reactionary. It may be rather rash amongst so many protoganists of the selection of boys for training, but I am not at all sure that education as we get it to-day is an advantage for a boy who is going to start in as a craftsman. In fact, I am rather convinced of the opposite. I would sooner from a bunch of boys in the street pick out in a few minutes' conversation two or three youngsters with that characteristic (Mr. Fleming would know the word—it is North Country) known as "Nouse," rather than six years of complete education as we know it to-day. I am quite sure that in the making of a craftsman, and by craftsman I mean a man who by his skill of hand and eye and appreciation of the tool he is working with can produce the best job from that tool, education does not play an important part. I am afraid I shall bring down the wrath of everybody, and Mr. Andrews in particular, on my head, but Mr. Fleming will no doubt reply and completely refute this.

Mr. Fleming spoke in the very early stages of his paper of female employees. He does not mention later whether his female employees are craftswomen or whether they are entirely unskilled. I should like to know whether Metro-Vickers have a system of training female labour.

After the introduction of the Metropolitan-Vickers training system the number went up to 20 applications for every vacancy. Can he say why this proportion rose to such a figure? I cannot well appreciate a boy of fourteen or fifteen years who, because of some system in a works which may become known to him, instantly rushes to that works. It may be due to the parents' influence.

Mr. Fleming spoke of psychology and there I must say I find myself in agreement with him, but I do think he is rather unfair. I take it the psychologist was forecasting what might happen,

whereas the Committee of the Metro-Vickers were saying from experience what had happened, and he admitted the gap between estimate and realisation was closing. I think this proves that the psychologist was very satisfactory.

Can Mr. Fleming give us figures for the percentage of boys trained by Metropolitan-Vickers who remain with that firm when they have completed their apprenticeship? I admit that the training given both practical and technical is of great value, but it might be that a large percentage is lost to Metropolitan Vickers when the apprentice attains the age of twenty-one or between the ages of twenty-one and twenty-two.

Mr. Fleming drew a comparison between the large firms and the small firms in this matter of training. If I understood him correctly he rather gave the advantage to the larger firms. Here again I am a reactionary. I firmly believe that, not a backyard firm, but a small shop enjoying a small number of well-trained craftsmen is far and away better training for apprentices than a large firm. I do not believe that the big modern high-production factory is really the best ground for training boys to become craftsmen.

MR. FLEMING: Ordinarily I like to reply to questions as they are raised. I think one can do so more fully thus, than collectively as I am asked to do to-night. That is partly because in the hurry of making notes one's writing is not always so legible as it might be.

Mr. Herriot and Mr. Whitehead raised the question of premium apprentices. We have never had premium apprentices in our factory. Twenty or thirty years ago the problem was raised as to whether we should or not. I was quite a youngster at the time, but had had a good deal of experience, and I suggested to the management that we could not afford to limit our field of choice in this way. This was agreed to, and we have never accepted premium apprentices. In some of the other firms with a similar name it may be different.

With regard to Mr. Herriot's question about 215 apprentice electrical fitters to 300 craftsmen in the same trade, I am afraid I did not explain myself clearly. I did point out, however, that in my list there were two trades where the percentage of apprentices appeared to be very high, and that this was because these trades were the jumping-off ground for men for promotion to works staff, drawing office, and design jobs. Also our factory is largely engaged on electrical work which requires an enormous range of skill, so that in many of the departments there are, besides the craftsmen, a great number of men who are specialists on certain jobs but who are not craftsmen. When you include these specialists and compare the total with the apprentices who will remain craftsmen it makes the relative proportions very different.

With regard to Mr. Herriot's question as to "feeling" existing between premium and non-premium apprentices, I have had no

experience of this. We have, however, something rather similar. In addition to our trade apprenticeship course, we select men from the universities, and public and secondary schools for training courses of two to four years' duration. These men work on the same footing as the trade apprentices but do not spend the same amount of time in any one department. Some of them have climbed up by means of scholarships, while others come from homes where there are means for pursuing higher education. I have never found any trouble through snobbery or any social difference to exist. If such trouble did arise I think the way in which things are run in our works would stamp it out. Whether that would be the case with premium and non-premium apprentices I do not know, as I have had no experience of this.

With regard to the work done by the apprentices in the electrical fitters department, this work is largely of an assembly character and permits of the employment of differing degrees of skill, and it is work where we give the men as wide a diversity as possible to give them a chance to increase their skill and gain promotion.

With regard to Mr. Whitehead's question as to whether apprenticeship should start at an early age in the schools, I have a great deal of sympathy with the idea at the back of this. Some time ago I tried to start a vocational guidance scheme locally. I have studied vocational guidance in many countries, and I feel that we have got to have some way of keeping records of characteristics of pupils. If school records could be kept consistently from an early age, I believe the information obtained from them would be of great value in vocational guidance. I am not quite sure that I would agree altogether with the idea of trying to produce budding mechanics at the age of five or six. Educationally it would not be a good thing.

Mr. Gibson raised the question as to rates of pay for apprentices and how they compare with other trades in the locality. I am sorry I have not got in my mind the rates of pay for each year of apprenticeship. That is settled by the employers in the district, and I cannot give you the rates off-hand, but I should be happy to send a list to anyone interested.

Mr. Andrews asked my view as to the relative value of part-time day as compared with evening classes. As far as my experience goes, I would attach the greatest importance to the part-time day classes. It would be very difficult, however, for all our boys to go to these classes, so what we do is to pick out a selected number of 20 to 30 to attend these day classes at our expense. The others go in the evening and pay their own way.

With regard to the question of examinations, a large number of both part-time day, and evening class, boys go in for National Certificates in Engineering, and the Associateships of such institutions as the College of Technology, Manchester, and the Royal

Technical College, Salford. Their courses form a very comprehensive and complete training. In fact quite a number of the men who take these courses compete well with the university men.

On the question of psychological selection and the school examination, one speaker did not attach very much importance to either of these two considerations. Well, I am very largely a believer in experiment, and while I have expressed my views on psychological selection I am inclined to view it very sympathetically. I think as much importance as possible should be attached to young people's characteristics as they concern suitability for employment. In our district we try to co-operate as fully as possible with the school staffs, and we encourage teachers to come round our works and see the kinds of employment available. We like to get the teachers to increase their knowledge of the different kinds of employment obtainable so as to assist them to advise their pupils as to suitable careers.

Mr. Herriot spoke about inspection. I would very much like to take him through our inspection system. I have seen a good deal of American methods and I would be quite prepared to put our inspection system against that of any American factory doing similar work.

In regarding different industries, I think they can be divided into two classes, one making producer goods, and the other making consumer goods. Producers good are used for the production of other goods, and consumer goods are made to be consumed, such as motor cars or things of that kind. In producer goods you do not get so much repetition work. When you make a 100,000 kilowatt turbine, you know you will probably get another to do in about two or three years time. There is not much repetition work about that. This means you must have extremely skilled labour. In my particular factory we have both kinds of goods and we have to have an efficient inspection, to suit. In considering this question you must not lose sight of the two main grades of industry.

Mr. Wills raised the question as to whether the training of craftsmen is a domestic or national problem. I always hesitate before encouraging national interference in industrial matters. I think the problem is of national importance but personally I would prefer to see the problem solved by those most vitally concerned with it. Those engaged on it must take the " broad view " and train men for their own and for other firms who cannot train them, because as an export nation it is important that we should have an adequate supply of trained workpeople in order to meet foreign competition. In spite of the fact that one may be helping a competitor, it is better to do this than to fight among ourselves and so help the foreigner. Mr. Kenworthy raised a large number of points. With regard to the first, Metro-Vickers train men to retain them. That is primarily

our object. We make it a cardinal point that if we meet bad times, we will not discharge an apprentice on the completion of his time. If he wants to leave he can. A small proportion leave, but a very big percentage remain with us over long years. There are men we have trained who now have sons in our works. On the question of promotion, we have very good and ample facilities for men to rise. About 15 to 20% rise from the bench to staff rank, as inspectors, foremen, ratefixers, draughtsmen, and so on.

Mr. Kenworthy also raised the question as to whether our apprentices are used on production, or are they regarded as being trained rather than used as producers during the first few years? This is a very important point. When an electrical fitter reaches the age of nineteen he is usually capable of producing certain parts, and when he reaches this stage he is given the same facilities as an adult workman. With regard to special piece-rates, if he is in a position where special piece-rates are given then he gets the advantage of these rates.

With regard to the question as to whether there is any need for craftsmen, if you consider the distinction between the producer type and the consumer type of goods, you will appreciate that there is, particularly in connection with the former.

Mr. Rowbotham raised the question of the training of female employees. When female school-leavers enter the factory they spend the first month or so in a training school where they are taught the elements of the trade they will follow, such as meter assembly, coil winding, etc., before being passed into a productive department. The work on which women are employed in the factory is mainly of the semi-skilled and unskilled type. They are not craftsmen.

On the question as to the percentage of boys trained by the Company who leave the firm when they have completed their apprenticeship, as it is the Company's rule that apprentices must be retained when they come out of their time, for at least three months, the answer is 100% remain. The percentage leaving after this period is less than 1% and this figure includes both those discharged, and those leaving of their own free will.

SIR WALTER KENT proposed a hearty vote of thanks to Mr. Fleming for his lecture.

RECRUITMENT AND TRAINING OF ENGINEERING CRAFTSMEN.

Papers presented to the Institution, Yorkshire Section, by H. C. Newell, M.I.P.E., and R. J. Mitchell, M.I.P.E.

Mr. NEWELL'S PAPER.

THE difficulties encountered in compiling a paper of this kind are numerous because of the many different ways in which the problem can be presented. One can regard it from the point of view of the employer, of the apprentice, of the State. It also presents psychological and economic facets to the discerning investigator, if the problem be considered as a whole. What then should be our line of approach to-night?

We do not think we can do better than consider the findings of the Select Committee convened by the late President of the Board of Education (The Rt. Hon. Lord Eustace Percy, M.P.), on October 31st, 1928, with the following terms of reference: "To advise the Board of Education as to the scope and methods of the Board's enquiry into technical education for the engineering industry, and to review the material furnished to the Board in the course of the investigation."

It is our intention to quote somewhat freely from this report in view of the fact that it is the most authoritative and searching report that has been made by the industry, for the industry, since the War. The constitution of the committee was as follows: Sir Dugald Clerk, K.B.E., F.R.S., Mr. R. W. Allen, C.B.E., Mr. A. E. Berriman, O.B.E., M.I.Mech.E., Mr. E. R. Briggs, (Works Manager of the English Electric Co., Rugby), Mr. J. T. Brownlie, C.B.E., Lt. Col. E. Kitson Clark, T.D., M.A., F.S.A., Professor Gilbert Cook, D.Sc., Mr. Charles Day (Managing Director of Mirrlees, Bickerton & Day, Ltd., Stockport), Professor S. M. Dixon, Mr. Allan A. H. Findlay (General Secretary, United Patternmakers' Association), Mr. A. P. M. Fleming, C.B.E., Sir Henry Fowler, K.B.E., Sir Robert Hadfield, Bart., F.R.S., Mr. Harold Hill (Works Manager of Dobson & Barlow, Ltd., Bolton), Professor A. R. Horne, O.B.E., B.Sc., Professor F. C. Lea, O.B.E., D.Sc., Mr. L. E. Mather (Chairman of Mather & Platt, Ltd.), Mr. E. C. Moyle (Principal of the Harris Institute, Preston), Sir F. Palmer, K.C.M.G., C.I.E., Mr. R. W. Paul (Director of the Cambridge Scientific

Leeds, April 30th, 1935

Instrument Co. Ltd.), Mr. S. L. Pearce, C.B.E., D.Sc., Mr. P. J. Pybus, C.B.E., M.I.E.E., M.P., Mr. W. Reavell (Managing Director of Reavell & Co. Ltd., Ipswich), Mr. H. R. Ricardo (of Ricardo & Co., Shoreham), Sir Archibald Ross, K.B.E., Dr. H. Schofield, M.B.E., Mr. W. Sherwood (Chairman of the Federation of Engineering & Shipbuilding Trades), Alderman Arthur Smith, J.P., Professor Dempster Smith, M.B.E., M.Sc.Tech., Alderman F. J. West, C.B.E.

The report was completed on July 17th, 1930, and published by H.M. Stationery Office in 1931. In compiling this report the committee interviewed a large number of witnesses and investigated evidence supplied by 277 engineering firms of importance, of which 42 were in Yorkshire. Such evidence is far weightier than any we could supply from our own circumscribed experience, and we submit, will be worthy of your most serious attention.

Recruitment: Industrial consideration.

"The first and most obvious industrial consideration is that while the age of entry into apprenticeship in the industry is usually between fourteen and sixteen years of age, the precise age varies considerably as between different districts and even between different firms in in the same district. A very substantial proportion of boys enter apprenticeship between the ages of fourteen and fifteen and many between fifteen and sixteen. It is quite common for a boy to spend a year or two in the works before he can become an apprentice. It is obvious that the practice as regards apprenticeship under the age of fifteen will require re-adjustment in connection with the proposed increase in the school leaving age from elementary schools. Over and above that, the present practice involves difficulties in connection with the recruitment of secondary school boys who normally leave not earlier than the age of sixteen, and to a certain extent of junior technical school boys who may leave when fifteen or sixteen.

"Other factors affecting recruitment are: (a) that it is common in all districts to give preference to recruits who are the sons or relatives of employees, or are in some way known to, and recommended by, them, and (b) that it is usually markedly difficult to recruit boys for foundry work. This is a matter which demands very careful consideration."

The report next deals with recruitment from different types of schools and in referring to public elementary schools says: "It is certain that a very large proportion, perhaps as high as 90% of the recruits to the industry, receive no full-time schooling beyond the elementary school and that of these the great majority leave at about fourteen years of age. Though we hope that other types of school will contribute more recruits to the industry in future, we recognise

that the elementary school will still be the most important numerically, assuming, of course, that there is no radical reconstruction of our educational system, and will continue to supply a very satisfactory body of recruits to the industry.

Junior Technical Schools.

"We, like all other committees of which we have heard, have received almost uniformly favourable opinions as to the work of schools of this kind which prepare for the engineering industry. Emphasis is laid on the fact that they are in close touch with that industry; that a proportion of the teachers have practical experience of the conditions obtaining in it; and that the vocational bias in the schools is found to be quite compatible with a good general education. It has to be remembered that the number of these schools is comparatively small. Their output to the engineering industry is probably not more than 2,000 a year and many employers, perhaps the majority, have no dealings with them. The question, therefore, arises whether a substantial increase in their number is not desirable and whether steps should not be taken to bring their existence, and the work which they do, more generally to the notice of the employers.

"We believe that the industry could profitably absorb a larger number of junior technical school boys. These boys are normally some of the most promising recruits and it is significant that they, perhaps more than any other class of young worker, realise the importance of increasing their qualifications by attendance at evening classes after entering employment. In saying this we have in mind that the progress of the industry continually renders necessary the introduction of new methods, new materials, and new machinery. To deal with these innovations, well-qualified and adaptable workers are required, workers, who, in our opinion, are exactly of the type of the junior technical school boy.

"At present those boys tend, in some cases, to pass forward to the drawing office and other sections of the works which are not immediately concerned with production. Such sections, must, of course, be suitably staffed, but, taking the industry generally, an increased supply of the junior technical school type of boy seems to us to be required for the benefit of purely productive work.

"This matter can only be brought to a successful issue through the closest co-operation between the industry on the one hand and education authorities and teachers on the other.

Secondary Schools.

"There is a marked tendency for boys from secondary schools to enter commerce or the professions rather than industry. The report of the Committee on Education and Industry states that in

1925-26 no less than 65.8% of these boys entered professional occupations, other than teaching or commercial or clerical occupations, and only 28.5% entered industrial and manual occupations.

"While engineering has probably recruited from the secondary schools as much as, if not more than, any other industry, it has undoubtedly been affected by this tendency. Not merely is the recruitment from secondary schools small in the aggregate, but also, as noticed by many witnesses, recruits gravitate toward the office side, including the drawing office, rather than to the shops."

It was noted that firms who have evolved definite recruiting schemes almost always aim at increasing the supply of secondary school boys who are frequently taken as "engineering" as distinct from "trade" apprentices.

"The number of such recruits which can effectively be absorbed will, of course, vary in different branches of the industry, and it is probably easier for a large than for a small firm to make systematic arrangements for taking them. But speaking generally, we believe that the policy of increased recruitment from secondary schools is intrinsically sound, on the broad principle that the industry needs a larger proportion of well educated young workers than it has at present.

"There are, however, serious obstacles in the way of developing this policy at the present time. In the first place, there is the tendency of secondary school boys and their parents to prefer 'black coated' occupations; a tendency which may divert them altogether from engineering, or if they enter that industry may cause them to choose the office side rather than the workshop.

"It is generally agreed that this situation is unsatisfactory, but in our opinion there is no simple remedy. At present some employers are too much inclined to select for promotion the boys in the office, who are probably better known to them personally than are those in the shops; a practice which unfairly weighs the scales in favour of the 'black coated' job.

"The cessation of this practice, however, would not in itself be sufficient to meet the difficulty. The contact between secondary schools and the industry which is usually though not universally defective, must be strengthened, and if a supply of the right type of boy is to be guaranteed, it must be made clear that prospects in the industry are reasonably good, that is to say, are comparable with those in commerce and the professions. If this can be demonstrated, and if full information as to conditions of employment and prospects are put clearly before the secondary school boy, his parents and his headmaster, we believe that recruitment from this source will be greatly stimulated.

"Another obstacle is the age of entry into apprenticeship which

in certain districts rules out a boy who leaves the secondary school at an age something over sixteen years when he has normally completed the minimum secondary school course. We consider that this question should be treated on liberal lines and that no boy, at any rate under the age of seventeen, should be precluded from entering apprenticeship on leaving a full-time school. Further, we think that the best method of securing this object is to regard the period spent at school between the normal age of entry into apprenticeship and the actual age when the boy in question enters, as equivalent to an equal period of apprenticeship. In view of the longer education of these boys, we have no fear that this concession will mean any lowering of the standard of apprenticeship, in spite of the shorter term of apprenticeship proper.

"It may appear somewhat inconsistent that we, like a large number of our witnesses, recommend both the development of junior technical schools and increased recruitment from secondary schools in which the instruction has no vocational bias.

"To this we would reply that the variation in the qualifications of the recruits is not in itself a drawback; that for a large majority of firms systematic recruitment from these sources will, for some considerable time, be in an experimental stage; and that, therefore, it would be dangerous to attempt to establish unity of type. Over and above that there is the practical consideration that the conditions for the successful establishment of junior technical schools are very well defined. It is extremely unlikely that, at least for a long time to come, there will be anything like a sufficient supply of junior technical schools in this country to produce the number of educationally well-qualified recruits which we believe to be necessary for the prosperity of the industry.

"Recruitment from universities and full-time technical colleges, though smaller is not dissimilar in character from that of the older boys from the secondary and public schools (who leave at about eighteen).

"A few large firms recruit from these sources, but generally speaking it is sporadic, individual and often determined by some special circumstance or some special requirement. From the information before us we think that the bulk of university engineering students who enter the industry are engaged in research, testing, design and salesmanship, rather than in productive engineering and its management. The comparative absence of university-trained men on the production side merits careful consideration.

"There is always the danger in the divorce of men with high technical and theoretical qualifications from the practical side of an industry, and our evidence shows that, with certain noteworthy exceptions this divorce is found in engineering.

"In our view, the universities ought to supply a valuable,

though by no means the only, element in the administration of the industry.

"It is, however, essential that men recruited from them should have first-hand knowledge of their fellow workers, and this can only be secured by experience in the works as distinct from such branches as design, testing and so on.

"If, in order to secure this object, the training of full-time students in universities and colleges is to be modified, there must be a definite and clear-cut demand for a reconsideration of the curriculum from the industry. It will also be necessary, if more university students are to be obtained for the works, to show that there are reasonably good prospects in this direction. At present we believe that university authorities are in serious doubt on this point and are unable to get a clear lead from employers.

Training in the Works.

"Both for engineering and for trade apprentices the normal method of training is through joining in the routine manufacture in the shops. In most large firms and many small ones the training is in the hands of a specially appointed person, frequently a foreman. On the other hand the number of firms who have developed elaborate systems of training is comparatively small.

"While we fully realise the difficulties which have to be encountered by the smaller firms, we think as a general principle that every effort should be made to render training in the works as systematic as possible.

"A very few firms have established 'nurseries,' but we do not wish to advocate specially this or any other particular method of dealing with the young recruit. We do, however, strongly recommend that in every case there should be a probationary period which need not be more than two or three months. During this period the boys should be carefully observed and their natural aptitudes noted, and as a result of this observation it will be possible to advise them as to the branch of the works to which they should proceed.

"It is of the utmost importance to the general efficiency of the industry that selection for different types of employment should be as well-considered and as intelligent as possible. We think that arrangements should invariably be made for the transference of 'trade apprentices' who show special ability to the grade of engineering apprentices, or alternatively such boys should be given a training wider than that related to a single trade in the industry.

"It is generally agreed that the training of young apprentices should be supplemented by attendance at part-time courses in a technical school. This matter will be referred to in more detail later, but we would remark here that our evidence suggests that

there is often room for closer correlation of works training and technical education.

"Some employers seem to do little more than give general advice to young workers to attend courses, though a very large number, perhaps the majority, go a good deal beyond this."

"Although the question of promotion is outside the terms of reference of this paper we cannot ignore it entirely since the methods of promotion may have a perceptible influence on the problems of technical education for the young worker.

"We are convinced that engineering should be a 'career open to the talents' and that every boy entering the industry should have the chance of rising to the higher positions.

"We think that the wise employer will do his best to encourage the progress of the abler boys of all grades, whether apprentice or not.

"It is not merely that this is in his own interest; it is an obligation that he is under toward his young employees, toward his fellow employers and toward the industry as a whole.

"The relatively unskilled machinist should be gradually introduced to machine work which involves increasing skill and responsibility; the selection for admission into some form of apprenticeship of young boys in the firm's employment should be most carefully considered, and finally, trade apprentices should as far as possible be given some insight into branches of the trade other than their own, while, as has been said, arrangements should be made for the transference of the best of the trade apprentices to engineering apprenticeship.

"Our evidence suggests that these principles are acted upon by a large number of firms, but it would be to the benefit of the industry if they were more widely and more deliberately adopted.

"From our immediate point of view, it must be remembered that a satisfactory scheme of technical education is impossible without the goodwill of the student; that ambition is an important factor in inducing a boy to begin, and persevere with, such education, particularly if it means evening work; and that his ambition soon fades unless he sees that he has a reasonable chance of rising by his efforts to more responsible and better-paid work. In that connection we consider that the record of a boy in technical classes should always be taken into account, along with his record in the shops when a question of transfer to a higher grade or of promotion of any kind has to be decided.

Part-time Education (Day Courses).

"We wish to record our approval of the principle of part-time day attendance and our hope that the system will be developed. We do not under-rate the difficulties of organisation which it in-

volves, especially in the smaller works, but we believe that the advantages outweigh any possible disadvantages and that the system is an essential factor in securing a well-equipped personnel for the industry.

"There is some force in the view that technical school instruction though often encouraged by employers, has tended on the whole to be too much the concern of the individual boy and too little related to the organisation of the industry; and so long as such instruction is received in the boy's own time this must inevitably be the case.

"Part-time day attendance systematically regulated means the formal recognition of the part which should be played by the technical school in engineering training. Such recognition must profoundly affect the attitude toward technical education of all young workers, even of those who are not chosen for day attendance."

Where a scheme for part-time day training is adopted it should, in our opinion, be first talked over with the foreman. These officials are in direct touch with the boy and have a pronounced effect upon the boy's outlook both toward his work and his attitude to study. If the sympathy and co-operation of the foremen toward the scheme is wanting or if any petty hostility is allowed to enter into its operation in the shops, then the scheme is almost certain to end in failure.

On the other hand if the foremen are informed of the scheme by the management before its inception, and their whole-hearted support solicited, it will reduce to a minimum the excuses for keeping a boy from attending his classes during the day. In order to ensure the satisfactory working of any scheme of part-time or evening education it is suggested that each firm should appoint some responsible member of the staff to take charge of the part-time and evening education of its apprentices. This official, who should have a knowledge of the educational facilities available within the area from which the workpeople are drawn, should be empowered to advise and suggest suitable courses of instruction to the apprentices and others interested. He would ensure the enrolment of apprentices at suitable schools, receive reports from the schools regarding progress and attendance, interview, periodically, the apprentices in order to ascertain whether they are meeting with any difficulty either financial or educational, and generally co-operate with the local education authority or technical school in all matters affecting the education of the firm's apprentices. In short, he could not do better than adopt the slogan which appears so often in our newspapers and periodicals—"Let me be your father." Such an appointment would do an immense amount of good since the apprentices would have the satisfaction of knowing that their attempts at self improvement were being watched and that when the necessity

arose they would be able to seek guidance from one in authority. Furthermore, when it became generally known that promotion was based on the joint reports of the foreman and the school or college it would tend to promote a spirit of healthy rivalry. It is a common experience among firms to find their brightest youths applying for employment with other firms because they feel they have reached a " dead end " in their present employment. Sometimes he can be induced to remain by tardy offers of increases in remuneration, or by " honeyed " words regarding his future prospects which may or may not be carried out, but the point at issue is this. Is it not a sound policy for each firm to devise a scheme of practical and technical training through which all apprentices shall be passed ?

Reports from the works departments and the school shall be considered twice each session, and those boys who do not reach a certain level shall be returned to the shops for specialised manual work which their attainments fit them for. The remainder will proceed with the correlated course of practical and technical training to a pre-determined point, covering say a period of four years, with a bi-annual sifting until at the end of the determined period the cream is left. These youths should ther be given every facility to learn the whole of the manufacturing processes and at a suitable stage should be transferred to the drawing office and finally to the commercial side of the organisation. Their training now being considered complete they should be given some minor executive post on production which will fit them for more responsible managerial positions when the opportunity occurs. If such a scheme was outlined and its contents explained in precise terms to the apprentices we feel sure that, in general, employers would have no need to bewail the desertion of their brightest youths, because every boy within the firm would realise that his future would depend upon his own efforts. A healthy competitive spirit would be induced and those who failed to " make the grade " would develop a respect and admiration of their more fortunate colleagues who in due course assumed command over them.

We wish we had the time to discuss, in detail, the many schemes of training instituted by the larger engineering firms at home and abroad among which such names as Metropolitan-Vickers Electrical Co , B S A., Royal Ordnance Factories, H.M. Dockyards, R.A.F., in this country and the American Tool Works Co., Pratt & Whitney, R. K. Le Blond Machine Tool Co., Taft-Pierce Manufacturing Co., Norton Grinding Wheel Co., Willy's Overland & Eastman Kodak Co., in America, are well known, but any one of these is a paper in itself and our audience will, no doubt, know how to obtain the information if they want it. The point which arises is this " can we afford to ignore the methods of craft training which the larger firms

in all industries both here and abroad, are so successfully operating to the mutual benefit of the employee, the firm, and the State?"

In conclusion, the development of craft skill is not dependent upon the time factor only. The acquirement of skill means a careful co-ordination between hand and eye and brain. The more the brain is developed the more will the eye perceive with a consequent improvement in dexterity. In pursuing a course of handicraft or machine craft training we are really undergoing a course of brain training and any scheme which aims at producing, as its ultimate aim, skilled workers must leaven its practical instruction with scientific principles and application.

Mr. MITCHELL'S PAPER.

YOU will doubtless agree that up to this point the ideas put forward represent what might be called sound views on the problem generally concerning the education of young engineers destined for the craft side of the industry. By sound views I mean the sort of ideas which one would expect from an industrial leader—an engineer—whose age is, say, between forty-five and sixty-five and who has therefore survived and triumphed in a world beset with obstacles and difficulties of every imaginable kind. The tendency of sound opinion of this kind is to be too scared about the cost of education and too much inclined to make its attainment rather difficult and never as easy as having your breakfast, which I think it ought to be. For example, it doesn't strike me as exactly sane to expect lads of fifteen to attend a night school three nights a week and to work forty-seven hours of that same week in a factory and then to do home-work in preparation for the next class meetings. This is, however, only in parenthesis. Let me proceed to my case in earnest.

It has been noted by the President of the Headmasters' Association that the public schools' attitude officially to the profession of engineering is that they would like precise information in regard to the prospects which it offers to intending entrants, also to know what kind of training is regarded as suitable for the entry of their protégés. The implication here is that "we" aren't sure at all that engineering is as good an investment regarded as a personal education as would be an equivalently thorough training in some branch of commerce or one of the non-productive professions.

The relevance of this view-point to the existing situation is compelling when we look round and note the large numbers of young men which the universities are turning out on a labour market already suffocated with claimants for jobs of very conceivable kind. Only the really brilliant ones amongst these young men stand a fair chance of making headway in the world of practical engineering, and frankly the time seems ripe to stem this tide of youth rushing in the wrong direction by making earnest efforts at vocational selection of candidates for scientific training in engineering at the universities.

Surveying the human field as it exists to-day in engineering I would suggest that there are some major conditions and tendencies which in our own interests as an industry and as an important part of a nation we should strive to correct and modify.

These are as follows :—

(1) The degree man without works training should give place in the future to a university trained man who has first spent four

years partly in the works (summer) and partly in the university. He then *starts* as a craftsman and gradually becomes a scientist as well.

(2) The employment of boys and youths on dead-end jobs should give place to a carefully planned system whereby from the age of fourteen or fifteen a continuous effort is made to *further* this education and training according to his capacity to benefit thereby.

(3) The employment of women and girls in industry should be curtailed to the maximum possible degree. But the school-leaving age of girls should be raised *at once* to sixteen as a minimum. Where financial hardship would result from this regulation the payment of a National Dividend to such women and girls would cost probably less than the present dole and ensure that home conditions in thousands of cases would be far better than they are now. When all is said and done the best women are the home-makers. And industry exists to support homes—or at least it should do to have any meaning left in it from the average man's viewpoint.

I mention these three major points because I believe they represent cardinal errors in industrial policy and errors of which there are many glaring examples in the field of engineering, considered broadly.

Now in regard to our subject—that of training for craftsmanship—there are certain main headings which are worthy of discussion.

The popular superstition that handicraft cannot be acquired outside a " real works " is disproved by the fact that most of the entrants of exhibits to such an event as the Model Engineers' Exhibition in London are not trained artisans or engineers at all, but simply men (and women too) who like working with their hands and who find a fascination in mechanical matters. By the way, how many of our industrial rank and file could make equally well the best of such exhibits as appeared this year ?

In reality, in an average modern works we find that there is little or no systematic training of the young employee—and for the following reasons :—

(1) Interference with production urged by the foreman.
(2) Foreman and supervising staff too busy.
(3) No spare plant and/or facilities available.

This results in dead-end jobs, no skill acquired worth mentioning, general facilities undeveloped, and standard of workmanship either poor or at least not necessarily improving.

To those who are concerned to try to rectify these defects in the structure of our industry I would suggest that the remedy lies in the provision of craftsmanship training centres—of which more later—and wherever possible—of a special section in every fair sized works where the training of youngsters in manual dexterity and

knowledge of processes should be just as much a part of the programme as the delivery to time of specified orders. This may appear to some as unpractical idealism. I personally believe that such provision would pay for itself within the first year of its inauguration. In some of the famous works of the past, especially the marine. works on the Thames, such a scheme as this was in operation. The department in one such works was known as the nursery.

The present-day complaint that really first class tool-room men are almost impossible to procure is the direct result of allowing the previous generation of super-skilled mechanics to die out without having given them the means to pass on the torch of their skill and aptitudes to the rising generation which was to follow them.

As a result we find that in certain phases of manufacture this country is definitely in an inferior class considered in regard to design, quality of workmanship, and price. Examples of this are ignition apparatus on automobiles, many kinds of scientific instruments, micrometers, small tools, precision machine tools for instrument making, and the more elaborate automatic machines on which combined turning, threading, drilling, chasing, and knurling operations are performed. The recent Machine Tool Exhibition at Olympia showed many examples of this better education—for that is what it amounts to—possessed by our rivals on the European continent. For, be it noted well! In many German works there are foremen and charge-hands possessing not only university degrees or technical high school diplomas, but also that versatile knowledge of production technique which can be acquired only by practical experience in many departments over a long period of years. We need to cultivate this type of engineer in Great Britain and it is one of the responsibilities of out Insitution to lead the way to such becoming a fact. Happily there are signs that the need for action is realised by those in authority and that well thought-out plans have been prepared in a number of important centres. Among these special mention should be given to the schemes prepared and in operation in Birmingham and Coventry. In Coventry the completion of apprenticeship together with the passing of prescribed examinational tests gives the ex-apprentice the privilege of the freedom of the city, a distinction which any young fellow who is proud of his city will naturally value. The Institution of Automobile Engineers has inaugurated an extremely useful scheme for raising the standard of motor-car repair men—a long overdue provision to eliminate, one hopes, the crass incompetence of the class of humbugs masquerading as skilled mechanics which it has been our unfortunate experience frequently to encounter.

One of the most comprehensive schemes in this class is that of the Leeds Technical College. Yorkshire is not behind in this vitally

important movement towards utilising to the full the potential capacity and genius of our young engineers.

Experience shows that the boy who excels in craftsmanship is generally the boy who is also good on the academic side, i.e., the bright boy shows an all-round brightness. It follows from this that boys who fail to reach a minimum standard in academic work very rarely show ability in the finer points of craft. Such boys in fact generally become ordinary machinists such as turners, millers, grinders, and so on.

In order to produce craftsmen of the highest grade it is vital that they should in their apprenticeship be given an intensive training in examples of construction and operation of all the usual types of machine tools, including the problems of setting up. A portion of the course should be devoted to handicraft such as general fitting and tool-room work of an especially accurate character.

The practical side of the course should be balanced judiciously with technical instruction on such subjects as materials used in engineering, including modern non-ferrous alloys and the various new hard metal cutting alloys, workshop processes, and calculations. Where time permits some attention should be given to elementary chemistry and physics, treated from an engineering viewpoint, and last but very important at least some elementary treatment of the theory of mechanisms should be undertaken.

Modern industry with its undue insistence on specialisation of function obtains its increased production often by blotting out mechanical aptitude in the broad sense. It behoves us individually and nationally to beware of this great danger, and to take steps to prevent the potentially serious results in declining national prestige which might otherwise overtake us.

Discussion.

MR. SEYMOUR said he would like to congratulate the Institution of Production Engineers on taking up this problem. It was most interesting to compare the position here with the position abroad. He had been shown by the Director of Education for the West Riding the courses which are now given in 12 of his secondary schools for metal and woodwork, each subject being taught by a man with a degree in engineering. They had also succeeded in getting the university authorities interested which was also a very great step forward in this district. Other countries were giving very close consideration to this problem—the question of raw material and the way in which it could be selected, graded, and then moulded into the form in which they required it. We were wanting every day turners, borers, drillers, universal millers, etc., and we found it difficult to get the right type of men, the shortage was quite acute in several branches of industry. But what abilities does a person require to do those jobs well? How was one to determine that a person had those abilities? How much mechanical ability do they want? Was mechanical ability a single unity that everyone could have—as much as a pound of tea—or were there different kinds of mechanical ability? Was there one kind or were there many kinds of mechanical skill? The fitter building a thing used a very different kind of mechanical skill to the turner, miller, or person of that kind operating a machine which he himself had set up. A person who worked in a toolroom was concerned with the quality of the job, a vastly different thing from the man doing a similar job on the production side. A machine repair man was very different from an ordinary fitter, but how alike on the surface. The qualities and the abilities of the persons to do the job for which they are called must be carefully considered. It was a fundamental problem when studied in that light—we study the metallurgical principles, cutting alloys, etc., which were advancing at such a high rate, the question of the right alloy for the different kinds of machines, but it really meant that one was doing the same sort of thing on the human material to obviate the "hit and miss" method.

Regarding secondary school boys, it was preferable that they should go forward to take an external degree. There were many points relating to education which should be carefully gone into by educationists and industrialists. Craftsmen should be helped as much as possible in their efforts to become highly skilled. They should be trained to see the job as a whole and educated so as to be able to train other craftsmen and to be able to take executive jobs. Such training would get rid of the present tendencies of

engineers to say "I am an engineer—don't you go in for engineering."

MR. J. D. SCAIFE said he did not intend to find any fault with the two addresses given. They had both been exceedingly ably given and both had shown evidence of first-hand knowledge of the subject, one from the academic side and the other from the practical side.

We only need to study the training of young engineers in other countries to realise that long ago the old idea of the excellence of the British workman had been exploded. It may have been true fifty years ago. To go around Germany, Sweden, and America, for instance, made him ashamed of the way we were handling the situation here. The reason was apparently the lack of co-operation between the academic side and the employers' side. Employers did not care—their whole thought about young employees was cheap labour, the cheaper the better. Employers did not mind what method of manufacture was used provided the goods were produced at low cost. This condition had got to be remedied and our Institution had taken the matter in hand and we had succeeded in getting the educational side to co-operate with us. We had offered our services and these had been accepted to assist in the scientific education of production engineers. That did not get down to the problem we were discussing this evening. It did not look after craftsmen. The co-operation of the hand, the eye, and the brain, that marked the man who was properly trained as a craftsman. A craftsman was a man who could do a job with the least possible amount of effort. Those were the people we had to train, but we were making very little progress. To start the job we must eliminate those workers who were going into cul-de-sac jobs. We could not go on taking boys of fourteen years of age and later pitch them out on to the street without a job. We came across them by the score, helpless human beings who were fit for very little except the job they had been engaged upon. They were not taught. It amounted to the fact that that was the job you would have to do until you were twenty-one, and we may or may not find you a job then. A boy who had been well trained could turn his hand to many things.

The education authorities must realise that there was a vast difference between an engineer and a boy who was going to turn loom spindles. What was going to happen to the boys who went into cul-de-sac jobs? They could not become engineers—there was not a chance in a thousand—they did not get the training. Many of the old hands of the game had their outlets in other activities, such as theology, gardening, and reading. Those people who were going into cul-de-sac jobs would have to be better trained than they were to-day. They did not get the pleasure from engineering that he did. They required to be trained to take a broader outlook, they must

see something more than the job they were doing. Employers should get into touch with the local engineering educational people and get them to recommend the boys who were finishing at the schools. He personally got boys from a local school at sixteen who were recommended by the masters as likely to make good engineers. They were given an all-round training in the shop and in the drawing office, and they were put into the positions they were best fitted for. But we should start earlier than that. There is the question of the parents' means to put the boys in the secondary schools at the outset. Many boys had to leave at fourteen for this reason. Masters should inform employers that certain lads were too good to go into blind-alley jobs and such boys should be helped in every possible way.

There was also the problem of meagre wages paid to engineering craftsmen. The job must be made worth while. The recent advance granted to engineers was all to the good and should have been more.

MR. TOWN, referring to the work of technical colleges in training engineering craftsmen, said it was most important that up-to-date information should be imparted to students and "rule of thumb" methods abandoned. The technical colleges provided the only places where apprentices could obtain a general knowledge of the operations of the various types of machine tools. The workshops of the technical colleges, therefore, should be representative of modern design, which makes very close co-operation between the technical colleges and industries most essential. That such co-operation could produce excellent results, both for industry and craftsmen alike, was evident in Germany. The machine tool as a subject was worthy of a more exalted position in the technical colleges than it at present occupied.

MR. NEWELL referred to a question raised by Mr. Scaife regarding education authorities training youths for design as distinct from production. Education authorities had nothing like that in mind. Speaking as a representative of an education authority, every lad had his opportunity. It must not be forgotten that public money was being spent and the training was there for every lad who had the ability to accept it, and speaking from twenty odd years' experience he found that the boys sorted themselves out; some went from strength to strength and became designers or executive officials, and those who found the meat very difficult to chew obviously found a niche on the craft side. Mr. Scaife had said that education authorities must endeavour to pay more attention to the training of this type of youth for production. Was it not the function of industry to make their requirements known to the education authorities and let them know what they really wanted?

They would be only too pleased to meet them and give local industries what they really wanted.

MR. SYKES said he had come that night to learn. One could not listen to papers like the ones just read without learning something from them and from the discussion. Such a meeting was bound to do a tremendous amount of good in crystallising a good many nebulous ideas of recruitment of staff. In his opinion the matter had perhaps a wider significance than had yet been mentioned. It really starts in an acceptance of a fundamental policy with all the implications of such a policy by those responsible for the financial side of industry. There are outstanding examples in this country where well-conceived schemes for the recruitment of staff had the genuine wholehearted support of the heads of the particular concern in question. This support was not merely permissive, but sprung from a conviction in the minds of those leaders of a commercial and ethical necessity for such a scheme. On the other hand, in the great majority of manufacturing firms in this country, the ideas which gave rise to such schemes were conspicuous by their absence. In his opinion no general adoption of well-conceived schemes of recruitment of staff to industry could be built on a sure foundation until there was a radical change in the minds of the leaders of industry, and in their conception not only of the commercial necessity of such schemes but of their moral necessity.

He agreed with much that Mr. Scaife had said in his remarks. To anyone with an intimate knowledge of the organisation of industry of some of our continental neighbours it would appear to be folly to ignore the evidence of the more or less general practice, which results in a better, more scientifically trained, and more highly educated staff, particularly in the grades downwards of works superintendents to and including foremen in a very large percentage of their works. There was a marked tendency in this country to consider the production personnel of an industrial organisation as being of a lower order than the personnel of sales, commercial, and financial sections, and this conception was reflected in the grading, ranking, and pay of such personnel.

MR. BATEMAN said that quite a lot of the points raised such as the selfishness of the employer and the faults of the educational authorities were due to economic conditions. In the first place, very few youths wanted to go into engineering to-day—the remuneration was too small, and they were consequently getting the wrong type. It would be better if educational authorities, in conjunction with schools and colleges, selected the correct jobs for youths. They usually knew, even better than the parent, the best job for which a youth was fitted. The decision about a trade started a long time before a boy was sixteen.

DR. MERRITT said we want more publicity on the advantages of engineering as a profession, and when that publicity started producing results then we must really get down to the business of selection in order to make sure they are not dazzled by publicity but are really equipped for the job. That is one of the main problems involved. We must select the right people. The other end of the problem was the point of view of management. We must convince the managements themselves that proper schemes were really profitable, produce £ s. d. There must be some incentive and we should perhaps then get a little further forward. The crux of the matter came down to publicity. Engineering employers must first of all be instructed into the advantages which must accrue from comprehensive schemes. It must be pointed out that great assistance could be secured from our educational institutions and they must again be educated to really want to put in such schemes of training as had been discussed.

MR. JACKSON said that his firm always had a waiting list for apprentices and they received a very thorough training in each operation. He had found no lack of craftsmen or apprentices.

CAPT. L. J. SERJEANT said the subject was one in which he was very vitally interested personally. Employers kept their industries going through hard time out of sheer necessity—when they were quite unable to spend money. The main point was the handling of human material. Unless attractions were there—reasonable livelihood, administrative and executive positions—we should not get the right type of men. He agreed with and welcomed Mr. Scaife's remarks about increases in pay. The men had got to have money to live, they had got to have reasonable wages paid to them to attract the right material. He would have welcomed double the amount of the increase. It was necessary to put our houses in order, and prices should not necessarily be increased. It was a question of how to get the men more money without the job costing any more.

He found himself at issue with Mr. Scaife about the fact that we were behind everybody else. Though he had not the advantages of knowing the Continent, he would like to know why it was that those people came to us to buy the best aeroplane engines? He could not take that view at all.

Another point raised was the moulding of the material. There was no mouldable material. Many industries had suffered here through trying to force British temperament—it doesn't go here. There was a difference between moulding and guiding.

MR. F. T. NURRISH stated he had been on the Continent and whilst one appreciated that the Germans and Americans did very wonderful things, they also did things very badly, and to his mind their average craftsman was not a patch on our own. On one

occasion when inspecting machines in South Germany the foreman of the shop had a rough time dashing about the shop measuring work. The skilled men would not take the responsibility of checking their own work, though they were able to do it. The workmen simply got the material out but the foreman had to measure it. The same remarks applied to fitting. He spent a month in those works and the foreman told him they had very few men whom they could trust out of 800 skilled and semi-skilled workers. There were only eight men in the whole shop they could send out to erect machines. The foreman himself was extremely skilled.

He had had a lot of experience of attempting to train craftsmen. About ten or twelve years ago his firm participated in a scheme of training, and did so to-day. About 100 apprentices had been sent, all told. His firm did not believe in screwing the last ounce from their employees and paying poor wages. They have a most generous scheme, they pay at least twice the amount paid by federated firms, perhaps three times as much. A youth of, say, sixteen, got an advance every six months until he reached twenty-one, when he was drawing 52s. per week. He regretted to state they had not produced many craftsmen of outstanding ability. Every boy had the same chance of participating in the scheme and everyone was given the same chance. On reviewing the situation and comparing the skill of those boys with apprentices in his days he regretted he could not see any marked improvement. He was not belittling the scheme, but he was disappointed with the scheme after ten years' working.

Mr. Brooks said he would like to say a few words on the actual recruitment of boys for craft training. It seemed to him that most of the boys who went into industry found themselves in one of the single purpose jobs, which Mr. Scaife had illustrated, and one found them going out after two years to enter a blind-alley occupation. He believed that if employers could formulate some scheme, some concrete proposition, which could be put in front of them where good progress and ability were recognised, say, after six months or twelve months, their case could be reviewed, their wages increased, and verbal encouragement given to them at the same time, a far better type of lad would be attracted, and stay there with the idea of becoming a perfectly good craftsman. Firms and apprentices were not too well related. You found foremen who appeared to think boys were there to get them over their production difficulties, and the happy personal touch between boy and foreman was missing. Boys should be allowed to visit other works, possibly manufacturing not very high class products, and then visit another works with a particularly fine toolroom and have it instilled into them what very fine products could be made. Such methods would do a lot to encourage the right type of material. We should not

worry so much about production engineers, we should endeavour to create really good craftsmen.

MR. SMITH mentioned that the number of boys from any one works who could attend technical schools, say two half days per week, was limited, perhaps half a dozen out of 150. He was afraid the selection of such boys was always biased. If a boy happened to be employed on a bottle neck he was not released, and conversely by attending technical schools in working hours boys were liable to miss opportunities of getting to know really important work. He could see nothing wrong with what most people had to do at night time, and stated that such men as Sir Alfred Herbert had done it. He wondered who had invented the idea of making technical school training a winter job. A man was an engineer all the year round, and he thought two nights per week all the year round were preferable.

There seemed to be a great tendency towards the production of managers rather than craftsmen. The trouble seemed to be that the cream of the craft were only offered something less than £3 per week. That was not much inducement to the universities.

Germany and America had been mentioned. He thought Australian methods might be of interest and related experiences there in 1927-31, and expressed the opinion that even with ideal conditions he could not say that it produced the results we were looking for. Piece work was made illegal, apprenticeship was binding upon the employer who, having engaged a lad, had to pay him for five years whether there was work or not. The boy had to agree to technical training equivalent to three evenings per week and the only way an employer could get rid of a lad was to appear before tribunals—a costly affair. That sounded very good and produced an excellent type of lad, equivalent to our engineering apprentice. Handy lads were illegal. The mental equipment of the lads was excellent, but unfortunately there was a scarcity of practical work on which to train them. Although those were ideal conditions, employers, technical colleges, and trade unions working hand in hand—a really first class scheme—he regretted to say he could not see a great deal of benefit accruing from it.

RECRUITMENT AND TRAINING OF ENGINEERING CRAFTSMEN.

Papers presented to the Institution, Glasgow Section, by J. McFarlane, B.Sc., M.I.P.E., and J. Wilson, B.Sc.

Mr. McFARLANE'S PAPER.

Introduction

THAT the accuracy achievable to-day in engineering and allied branches of industry is ultimately traceable back to the skill of yesterday's handicraftsmen is almost axiomatic. The finest tools and measuring appliances used in modern manufacture represent in themselves the accumulated skill of many generations of craftsmen. Modern trend in manufacture is to supersede the craftsman as a tool of production by some of his own handiwork in the form of machine tools, jigs, etc., and, in consequence of the greater productivity of the latter, the balance of skilled to unskilled labour has shifted, until the former is no longer so strong percentually.

This trend has been sufficiently gradual for the unbalance to adjust itself in the matter of supply and demand. The incentive to attain to a high status of craftsmanship has waned. By that I do not mean that the need for the same high level of skill no longer exists, but rather that the need is confined to fewer numbers and moreover the pecuniary incentive is also lacking and on that account the crafts are less eagerly filled by ambitious trainees.

In the Clyde district this condition is definitely noticeable and highly skilled tool makers and mechanics are not attracted here by the incentives offered them. In many cases semi-skilled labour, employed in tending accurate machines in large production plants, is paid a higher wage than the handicraftsman who built the plant and gave it its basic accuracy. So long as such conditions exist, so long will it be found difficult to attract the right type of individual into the crafts.

Recruitment and Training.

Broadly recruitment may be divided into two classes: Boys with a view to apprenticeship; men whose apprenticeship is completed.

Composition of the Raw Material.

In the majority of instances candidates are at school leaving age. Selection should be made as the result of answers to a questionnaire, a simple test and a personal interview. The object of this is to ascertain the presence of characteristics best calculated to form a foundation for future training. Where more than one branch of engineering is employed, the process of segregation is slightly more complex, but the same principles will hold with differences only in the details. While many characteristics are involved, three groups especially play an important part in the future of a craftsman, viz., natural ability and manual dexterity, imagination and ambition, grit and perseverance.

What influences a boy to seek to became a craftsman? Probably his education is a standard one, intended above all to help him become a good citizen irrespective of his later trade or calling. I take it that boys destined for the higher technical, commercial or professional walks of life have already decided to stay on at school and that giving some of these a form of practical training at a later stage falls outside the scope of this discourse. But what of the majority whose parents' positions force them to enter the industrial arena at the minimum age? Has any part of their schooling tended to reveal their bent either to the teacher, the parents and—not least—to the boys themselves? In other words, has the germ of any sort of ambition taken natural root in their minds?

Some form of manual training is sandwiched into a scholar's education. All trades cannot be catered for and woodwork is probably the most common form employed. Much useful knowledge can be derived from a careful study and analysis of the boy's reaction to this practical form of training, but I am afraid that the modern school teacher has so many other clerical duties forced upon him, that little time is left for practical consideration of this useful adjunct. Hence a great opportunity is missed of amassing data valuable in aiding a boy to obtain the most suitable form of employment compatible with local conditions.

Perhaps the greatest factor is the parents. Their efforts and decisions are coloured by circumstances and hence many a boy is pitchforked into an unsuitable occupation, because the parents are forced to get the optimum financial return at the earliest possible moment, regardless of what the situation might be in say two or three years. Or it may be that authoritative advice from an influential body is lacking. Many localities have fortunately set up advisory committees for juvenile employment comprised of employers of various classes of labour or their representatives, whose experience and influence are often of practical value in this work. Such assistance is, however, partly negatived by the parents' needs or lack of appreciation, but it is also hindered by lack of

specific detail in the school reports. What does the remark "woodwork, very good" particularly convey on a report card? Does if indicate speedy execution, accuracy, capacity for fitting parts together, preference for the more intricate work, close attention to quality of finish or presence of artistic expression and in what proportions? Will the general remark help in the choice between trades such as joiner, patternmaker, turner, millwright, or gauge or toolmaker? I admit that even the closest and most accurate analysis will not yield 100% good results, as too many other factors enter into the equation, but surely a good start is better than an uncertain one.

Before leaving this question and without wishing to criticise unduly our own school systems, I would refer to the system employed in Germany. Where they reckon that, by the age of 10, the directional capacity of the child's development is already asserting itself and where they have four clear years thereafter to study in closer detail the vocational trend in those boys not destined to a higher school education.

Probationary Period.

Successful applicants, having surmounted the first hurdle, are often employed till the age of sixteen as store and message boys, making themselves generally useful and using eyes and ears to imbibe the optimum of information regarding use of materials, tools, and processes. Boys then in the first half of the formative period in their lives should not be allowed to drift along without just enough control not to break their growing sense of independence. During the probationary period there must arise many opportunities for discovering the trend of a lad's capabilities. Those in charge of them have a rare chance of assisting in this work.

Boys are expected during the winter months to attend evening continuation classes. Those not at the Intermediate certificate level must attend a preparatory course and obtain a certificate of proficiency before passing on to the technical or trade classes. A boy's reaction to this schooling, together with his general conduct during the probationary period, should make the selection of apprentices very much easier.

Apprenticeship.

For the next four or five years the training of the youth becomes more specialised. He has commenced his apprenticeship. Methods of training are most diverse and can only be touched upon. We have the small shop, which tackles all sorts of odd jobs where employees must be ready to switch over from one machine to another or to the bench or smithy or hardening furnace. The apprentice is not made an exception to this system and he usually

gains a thorough all-round knowledge. The disadvantages generally are lack of up-to-dateness in method and lack of system in the young man's training.

At the other end of the scale there is the very large establishment with highly specialised departments, where youths often serve their time say as turners, millers, or fitters and, while becoming expert at their particular section, learn little else. This is not a true apprenticeship, but is a restriction of such imposed by over-industrialisation.

A large firm will serve its own ends best by taking a broader outlook upon the future of its apprentices. It is true that a certain percentage of young journeymen drift from their original "fitting-out basin," to use a marine term, but this is good for the trade as a whole and moreover they often come sailing back home again drawn by their earlier associations. Tradesmen who are too highly specialised seldom get the opportunity of enlarging their experience and of thus bringing back new ideas into the shops. In my opinion the all-round training of the small shop is to be preferred to such a circumscribed, though very particular apprenticeship, but it lacks modernity and method. The ideal is probably seen most often in shops of moderate size run on modern lines where the heads are keenly alive to the value of a systematic all-round training for their apprentices.

Many of the large establishments get over the difficulty presented by their extreme specialisation by maintaining an apprentices' department, where boys are given a good all-round training, actually producing useful tools and work for the concern. This department can be used to fill vacancies—even temporary ones—as they occur in the production departments. Furthermore this scheme relieves the production man of the extra responsibility connected with a training scheme.

Combined with the practical aspect of the question is that of their technical education. The apprentices' section is the Tom Tiddler's ground for future staff men and shop foremen and therefore a technical education should be encouraged. Different schemes for this are in practice : (*a*) Evening classes during the winter months ; (*b*) portion of the week set aside for attending day classes outwith the works ; (*c*) classes within the works themselves.

The affiliated courses for the whole of Clydeside run in conjunction with the Royal Technical College under a joint committee with a specially appointed organiser from a particularly fine example of type (*a*) and this is the type mostly favoured in the district. Type (*b*) is commonly applied in Germany and other Continental countries while type (*c*) is naturally confined to very large concerns. All have their respective merits which are fairly obvious.

Dealing with (*a*) as being more familiar to us, a fair proportion of apprentices manage to keep up with the prescribed work of the courses, but the majority fall behind, perhaps only gradually at first, until they are completely out of step and they become disheartened in the end. The fact was put forward by the writer, at a meeting of a joint committee to consider the mathematics curriculum, as a plea for an easier alternative for the average student. It received no support from the heads at the College. In more recent years, however, a suitable alternative course for boys with merely average technical ability has been developing. I refer to the trade classes at the Stow College and elsewhere. This feature will be treated this evening by a specialist in the subject and I believe his contribution will be most illuminating.

From my own experience I am firmly convinced that at the end of an apprentice's second year a complete review should be made of his practical and technical development with a view to deciding whether his training should be more technical or more practical and I believe that the Stow College now offers a suitable alternative to engineering apprentices who have only made average headway at their technical classes.

Journeymen.

Young men fresh from their apprenticeship will, in the majority of cases, have a desire to rove a little in search of further experience likely to enhance their commercial value and they should even be encouraged to do so, unless earmarked for special work. If this were generally acted upon, no firm would have a reason to complain, as what they lost on the roundabouts they would probably gain on the swings. Naturally allowances require to be made in the case of specialised trades, but in a short paper like this we are confined more to generalisations.

When selecting young journeymen for employment, it is essential to gain as complete a picture as possible of what their training has consisted. From the letters of application one receives, a general lack of appreciation of essentials likely to form that picture is obvious and it becomes necessary to formulate some standardised questionnaire for the purpose. The framing of such a questionnaire is a matter deserving of considerable thought before committing to print. Possession of a standard certificate by a recognised body and of a specimen of one's craft, as is the case in Germany, would go a long way towards solving this. Of course the proof of the pudding is in the eating thereof and the man can always be given a trial, but in all fairness to both the firm and the man, the more exact the information given on the one side and understood on the other at the time of application, the less reason there is for after-regrets either way.

Young men should also be encouraged to improve their knowledge of their own and closely allied trades by continuing, at least for a few years after apprenticeship, their study at trade or technical classes. It is not necessary to confine one's work to the subjects immediately connected with one's own craft. There are many others on the fringe which are invaluable and instances arise where the man so equipped has a distinct advantage over his fellows in competitive employment. One more remark before closing this phase of the subject. It should be accentuated that we are not out to support the jack-of-all-trades and master of none. The young man must have a mastery over one craft at least, to which the others, while of value, are subsidiary. We are discussing the question of craftsmanship, the possession of which is something to take pride in. Therein lies the chief difference between the skilled and the semi-skilled worker, the first having a conscious pride in his undertakings which the second usually lack. Let him zealously guard that heritage by learning diligently from his elders during his youth and imparting generously from his own experience to those who will some day succeed him.

German System.

The System in Germany may be described briefly as follows: The Guild and Craft Brotherhoods, dating from 1300 basically guaranteed to every handicraftsman his job, the employment only of high class workers and good training for the apprentices who became the next generation of craftsmen. With the rights and autonomy gained by these guarantees was bound the responsibility of assisting one another in times of stress. The broadest possible training was ensured through an apprenticeship of four to seven years (the latter duration in the case of bell founders and the like) under a mastercraftsman, towards the conclusion of which a specimen of his craft had to be prepared by each apprentice. This was included as part of an examination presided over by the district council of the Guild. Successful candidates became "Gesellen" or Guild Comrades. Another name given them was "Wanderburschen" or Journeymen, implying their next period of training. They started out to gain wider experience in their craft in other parts of the land.

The guilds were so well organised that the journeymen could find accommodation in all parts of the country in special hostels, and these were the progenitors of the present Youths' Hostels. Thus they lived among a collection of young men drawn from all quarters. The cultural influence of the exchange of experiences, minstrelsy, and learning thus brought about has been enormous and can be roughly estimated in one direction alone in the great wealth of folksong and folklore existing to-day in Germany. After

a period of years the journeyman was at liberty to prepare another and more advanced sample of his craft and to offer himself for examination for his Mastercraftsman's Certificate. His records were very closely scanned at this period ere his charter was signed, as the charter entitled him to employ apprentices and journeymen of his own. Herein lay the guarantee of the good training of the oncoming generation.

The introduction and growth of large scale industry, brought about by the competition with other lands has done much to destroy the power of the guilds. In fact from 1880 onwards their influence has waned tremendously. The War and the crises which followed it almost extinguished a large part of the activities of the guilds. Young journeymen found themselves unable to get work or to travel elsewhere in search of employment and further experience. Apparently the new régime is keenly alive to the leavening influence of the system of enlarging experience by wandering about and there has in the last two years been a resuscitation of this aspect of the guild organisations under Government support.

While the guild system has largely disappeared, or rather has become transformed, the general principles of apprenticeship, of producing a journeyman's sample and submission to examination, still hold. Many large industrial organisations have their own apprentice departments. Under the care of a master craftsman the boys undergo a splendid all-round training which partly extends into the works departments. Theory supplements practice. As well as the trade schools, which the apprentices attend for certain periods per week as laid down by law, where not only reading, writing, and mathematics, but also sociology, rights and responsibilities of citizenship, history, and not least, the theory connected with special branches of the trades are taught, there are also special classes on management and associated subjects in the works themselves. Also the physical well being of the boys is closely cared for in a thoroughly organised manner.

Naturally such organisation do not wish to lose the youths they have specially trained. One firm I have in mind trains not only nearly all its own skilled labour, but also provides its sales organisation with reliable repair mechanics, a very wise policy indeed.

American Practice.

As elsewhere, this is most diverse in character, but I have tried to get the personal views of a very practical friend of mine upon this subject.

The only trade school he claims experience of is the Ford School, originated by Henry Ford, to increase the supply of skilled labour for the tool room, etc., and I cannot do better than give a synopsis of the letter.

It was a good scheme, boys starting at fourteen years or upwards, but in exceptionally needy cases (sons of workers killed or injured in the factory) the age might be as low as twelve. The rate of pay started at 12 dollars per week. Training consisted roughly of two-thirds class work and one-third practical work (including both machine and bench work) covering a period of at least three years with sliding scale of wages based upon age and progress. Examinations were set and marks awarded, a certain minimum percentage being necessary for a pass into the factory at the end of the period when they still had to attend school one hour per day in their own time. They were very strict about the teaching of mathematics and the general impression gained of boys receiving this course was extremely favourable.

Mr. WILSON'S PAPER.

IN the time at my disposal I shall outline the policy being pursued in Glasgow for the training of craftsmen, the principles upon which that policy is based and the present position with regard to the engineering craftsman. I have two good reasons for presenting the subject before you in that form. Firstly, the engineering trades classes are not yet organised on a basis in the slightest degree commensurate with the great importance of the industry in this district and, secondly, the experience gained in the organisation of classes for other trades and their rapid development will no doubt be enlightening to you as indicative of what can be achieved when the proper spirit, interest and co-operation exists.

It is our firm conviction that for the successful organisation of classes for any trade a tripartite co-operation is absolutely essential wherever that co-operation can be secured. The three parties are the educationalist, the industrialist and the employee. By educationalists is meant the education committee of the corporation and its permanent education officials, by industrialist is meant the employer himself and any associated body of employers, and by employee is meant any association of employees usually a trade union. It is not always possible to get the necessary co-operation of these three parties because in some trades no appropriate association of employers or of employees exists. When classes are set up for any trade the policy is to form an advisory committee composed of representatives from the employers' association, from the trade union and from the education office under the chairmanship of an employer. The duties of an advisory committee are to discuss and regulate all matters concerning the training and recruitment of apprentices engaged in the trade such as the conditions of entry into the classes according to the requirements of the trade, the nature of the courses and the schemes of work, the staffing of the classes with the right type of teachers, the issue of certificates and diplomas recognised locally, and in some cases nationally, throughout the trade, visitation of classes and, in general to link together the educational and the industrial sides of the trade to the mutual benefit of both. Not the least important feature of such committees is the better understanding engendered between employer and trade union official by their meeting and working harmoniously together in the interests of their trade, sacrificing in many cases a considerable amount of leisure time. In addition, one cannot overlook the assistance afforded by some employers in the acquisition and donation of plant required for the work of the classes or the bonus and prize schemes which have been instituted as incentives to the ambitious students.

The success of this policy of co-operation is clearly illustrated by the statistics I have before me showing the growth of trades' classes in Glasgow since 1920. In that year there were 10 trades provided for with total individual enrolments of 827, in 1924 the corresponding figures were 12 and 1,246, and in 1934 these had increased to 43 and 5,142. In a period of fourteen years the number of trades catered for increased by over four times and number of students by six and a half times. These figures speak for themselves.

For the 43 trades there are 25 advisory committees in being. The most highly organised of these is to be found in the printing trade which may interest you. There are nine sub-committees each with its own convener, one for each section of the trade, such as letterpress, lithography, litho artists, bookbinding, paper rulers, etc., and both employers and employees are represented on the committees. From those committtees there is appointed a joint advisory committee whose function is to co-ordinate the work of the sub-committees, so that no branch of the trade is overlooked. With the guidance and assistance of the committee the School of Printing has been equipped very completely with modern plant and machinery. The individuals enrolled in the classes this session total 600 and it is now essential for any boy who wishes to succeed in his trade to attend the classes and obtain the certificates. A fairly high standard of entry into the classes is set as apprentices must possess the Day School Certificate Higher or attend a Preparatory Course of Study.

Not all of the trades have such a highly developed scheme as the printers but there are some closely approaching it, for example, bootmaking, carpenters and joiners, decorative trades, hairdressers, plasterers, plumbers, and so on.

What is the policy adopted in organising trades' classes? It is to give instruction designed to improve apprentices intellectually and as craftsmen, enabling them to qualify for promotion. It is a wrong impression that trades' classes exist to teach apprentices their trade and so fulfil a function which should be performed in the workshop. Trades' classes *do* help an apprentice to learn his trade by familiarising him with some aspects not available to him in his daily work and trades" classes do undoubtedly lead to more dexterous manipulation of the tools of the trade but that is achieved mainly through inculcating a thorough understanding of the theory and scientific principles underlying the methods and processes. At the same time to benefit to the fullest possible extent from his class instruction a student must have daily employment in a workshop, and for that reason there is imposed a condition of attendance at all trades' classes that the student must at the time be engaged in his trade. A glance through the syllabuses of some classes reveals the following: *Lithography:* History—Discovery

and development of Lithography. Materials—Nature and use of the materials commonly used on Lithography, gums, acids, French chalk, resin, paraffin, turps, etc. Inks—chemical and physical properties of pigments and mediums. *Bookbinding:* Staining leather—Chemical action of the ferrous salts, their properties and combinations. *Boot and Shoe Manufacture:* Theory-Orthopædics—Anatomical construction of the foot, causes of common diseases and their mechanical treatment. In carpentry and joinery, masonry and brickwork, slating and woodcutting machinists courses one evening a week is devoted to workshop practice and one evening to workshop drawing and calculations and there are interspersed lectures on timber, stones, and composition and manufacture of bricks, etc. It is very largely a question of the gilded pill in trades' classes and it is surprising how much technical and scientific matter can be covered and assimilated simply by a practical approach and by stressing the immediate practical bearing of that matter. It has astonished me in going round the classes to find the elaborate developments of surfaces accomplished by the sheet-metal workers, the intricate constructions in tangency drawn by joiners for the moulding profiles and so on. You can rest assured that the trades' class produce a better craftsman by other means than the mere handling of the tools of his trade.

The rapid development of trades' classes in Glasgow has brought about a much-needed centralisation of these classes. There are now five principal centres in the city, namely, Stow College, School of Building and Allied Trades; Stow College, School of Printing and Allied Trades; Stow College, School of Hairdressing; The Decorative Trades' Institute; and the new trades' school called Stow College. The first four each houses from 400 to 600 students and the new school about 1,500. It is intended, in due course, to make the new school entirely a School of Engineering and it has been very thoroughly equipped with machine shops, workshops, foundry, welding shops, and a complete range of laboratories. But we have a long way to go before the organisation of the engineering trades' classes can bear comparison with that of the other trades' classes.

To-day in Glasgow the technical student is well provided for with his Junior and Senior National Certificate Courses, but the needs of the trades' student are being fostered by the educationalist only. A mechanical engineering trades' course was inaugurated this session and the complete list of engineering trades' courses in existence are: boilermakers(27), electrical installation and power units (190), locomotive engineering (60), marine engineering (300), mechanical engineering (120), shipbuilders (40), structural engineering (100). We are led to believe that the complete success of trades' engineering courses will not be assured until: (1) The necessity of such courses is accepted on all hands and (2) tripartite co-operation

is established. The necessity for these courses is denied in many quarters and it is difficult to understand why. The stress of modern competition compels the employer to neglect the training of the apprentice as a craftsman, he is part of the productive system, he gets a lop-sided training invariably and he is not adaptable. A trades' course would assist very materially to fill in the gaps in workshop training. Then again one must realise that there are two separate streams of recruits flowing into the trade, first those aiming at and capable of attaining the higher posts and second those aiming at becoming, in the first instance at least, craftsmen. It seems obvious that a purely technical course will be acceptable to the first group but anathema to the second group. And I believe the survival percentage figures of the existing technical courses proves that on an average 1.5% of the first year entrants gain a junior certificate and 0.5% a Senior Certificate. Compare this for one moment with the survival percentages in some of the trades' courses. 21% of the first year entrants to the carpentry and joinery course and 24% of the painters and decorators gain certificates on the completion of their five years' course and 51% of the plumbers on the completion of a four years' course. The engineering technical course shows up in a bad light in that comparison, but the entire blame cannot be attributed to the technical course as such, rather to the many misfits in the course. There is surely room for two courses in the training of the engineer. Technical courses for the 5 to 10% of the total personnel in the industry who reach the higher posts and trades' courses for the remainder.

Even if the necessity for this division were accepted there is required the co-operation of all parties. There is no advisory committee in existence for any engineering trades' classes. with the exception of the locomotive engineers which I had the good fortune to form just this winter. My ideal would be to have an organisation akin to that of the printing trade. Sub-committees for each branch of the industry with a joint advisory committee in order to bring the greatest number of apprentices into the scheme I would like to see a system of day continuation classes instituted, so that employers who could so arrange it would allow apprentices to attend the trades' schools for one forenoon or afternoon a week, and where apprentices could not for some reason be released during the day they would be requested to attend in the evening. Technical classes would be held in the evenings and the technically minded youth would be free to attend these classes as he desired. The idea is not impracticable and if put into operation it would prove exceedingly beneficial to the industry as it has been to the other trades I have cited and would place the recruitment and training of the engineering craftsman on a properly organised basis.

Discussion.

In the discussion following the reading of the two papers, the tripartite basis upon which the work of vocational training was carried out (in such institutions as the Stow College, Glasgow), was regarded as being indispensable and the comparative dearth of vocational training was deplored.

Day attendance at technical classes was advocated generally, and evening classes were looked on as a necessary evil, having regard to the often arduous nature of the apprentice's daily work.

The meeting greatly favoured the establishment of "works" schools on the premises of the employer and it was suggested that the Institution take a census of such schools throughout the kingdom, with a view to ascertaining the exact position in this respect. At the same time it was recognised that small firms could not offer educational facilities of this nature but, in palliation of this, it was noted that not infrequently—as Mr. McFarlane brought out in his paper—the small shop had in its daily work, some of the characteristics and advantages of the trade school, notably with reference to the development of versatility.

The vocational test that used to be carried out in Germany during the craftsman's training, as mentioned in Mr. McFarlane's paper, also received favourable notice. The production by the apprentice, of some piece of work independently certified as being wholly his own was deemed most valuable, and, in this connection, the scheme lately initiated by the Institution of Automobile Engineers, whereby examinations in practical craftsmanship are held, followed by the granting of a certificate to garage men, was regarded as a step in the right direction.

Mr. Wilson's paper made it quite evident that the printing trade had taken every advantage offered by the vocational training facilities provided in Glasgow and had greatly benefited thereby.

It was generally agreed that the first two years of a boy's time in the shop could be spent to better advantage and made more valuable, both to the boy and his employer, by the provision of a better class of what, for want of a better name, might be called "tutor." Such boys, it was averred, were presently under the control of adults of the storekeeper type—due probably to the fact that the boys were used as messengers.

In so far as Scotland is concerned, the abolition (on a national scale at least) of the intermediate certificate was regretted. It had offered, during its existence, a standard yardstick against which the youth of the country could be measured with confidence.

The underlying economic basis of the shortage of recruits to engineering was recognised and emphasised during the discussion and, in connection with this aspect, it was suggested that security of employment, if achievable, would tend to offset the disadvantage of low pay in the eyes of potential craftsmen and their guardians, though it was further noted in this connection, that the degree of security at present existing in our works was bound up with the versatility of the tradesman.

THE RECRUITMENT AND TRAINING OF ENGINEERING CRAFTSMEN.

Paper presented to the Institution, Eastern Counties Section, by C. C. Ferguson, M.I.P.E., A.M.I.Mech.E. F.R.S.A.

Preface.

THE problem of recruitment and training for craftsmen in the engineering and allied industries is one which demands, by reason both of its dimensions and of its importance, the closest and most sustained deliberation of every person responsible for the prosperity of the industry.

It is one of the most difficult things to appeal to different sections of people upon the same subject when these sections view it from a different angle.

There are many hundreds of thousands of different opinions and temperaments in the world, so I shall not be surprised if, at the conclusion of my address, I find some persons present in disagreement with me. It is not desirable that all men should think precisely alike, since it is often the conflict of opposing ideas that most clearly brings the truth into view.

When I recognise the necessarily wide diversity of opinion on the subject of my address this evening, I cannot be too insistent in my wish to have others think as I do myself. I hope, however, that the subject we are at present considering will receive your serious thoughts and that, at the conclusion, there will be many views put forward, because in this way we shall be contributing something which will, I hope, assist towards solving some of the difficulties we are at present up against in the engineering and allied industries in our endeavour to find a solution to a serious and important national problem. The national habit of merely moaning that effects follow causes without doing anything about causes will have to end if we are to retain our place in the front line of the manufacturing nations of the world.

The growth of engineering is so well known that it is not my intention this evening to survey the ground which has been covered since the Industrial Revolution, which occurred towards the end of the eighteenth century. My object is, primarily, to deal with the immediate present and the near future, and to emphasise that

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the problem of providing sufficient skilled craftsmen is a responsibility to be shared and solved by all engaged in the industry. I do feel however that at this stage some reference should be made to the methods of training used in the past by craftsmen; before the present era of specialised and intensive production, which calls for the continued development of machinery, the craftsmen, assisted by an apprentice, produced articles by applying his own thought and skill to material; to-day, except in very few instances, he is called upon to carry out any development work, yet it is essential that, in order to fashion pieces of mechanism to the limits of tolerance which are permitted in the industry, he must have the ability to use his tools with efficiency and also possess the theoretical knowledge to guide him when presented with problems which, in some cases, need solving by calculations which are far from simple arithmetical ones.

Despite the opinions expressed in some quarters, the author is confident that the advent of machinery and mass production has not superseded handicraft. With the increased adoption of machine methods into industry, specialised knowledge is required for operating and maintaining the machines and more attention must be given to planning and controlling work. At no time in its history did the engineering industry of this country stand in greater need of highly skilled craftsmen to enable it to overcome the many obstacles which at present beset its progress, both within this country and abroad. Apprenticeship policy in the engineering industry has for a long time lacked a clear object, owing to the existence of different schools of thought and different estimates of the capacity of the industry to absorb the apprentices on the completion of their training. It is no use thinking only of to-day and to-morrow. We must endeavour to visualise conditions ten years ahead; the continued introduction of labour-saving machinery and mechanical devices of all kinds for handling articles hitherto manufactured by hand demands an ever-increasing number of skilled craftsmen for the manufacture and maintenance of such machinery.

It must be remembered that the standard of goods demanded from engineers to-day is much higher than it used to be, and it is reasonable to suppose that the standard will be even higher in years to come. I take this opportunity to plead for the better organisation, co-ordination, and dissemination of training to produce skilled engineering craftsmen; I feel sure that if this problem is faced by all of us conscientiously it will settle much in the future that otherwise must remain doubtful and uncertain. The strictures upon the incompleteness and inadequacy of the methods followed in some sections of the engineering and allied industries to provide

the necessary training to produce skilled craftsmen are amply justified.

It is well known that with the new developments which are rapidly taking place in the industry, there must be an element of uncertainty as to prospects, but this should not deter youths from entering it, as the risk is always present in any industry developing fresh ideas. It is the ever-changing methods of production in the engineering industry which give the opportunity to individuals to progress according to the initiative and skill displayed from time to time in their work.

Persons responsible for engaging apprentices and learners should realise that such youths are selecting their vocation for life and the employer or his agent should endeavour to find the *particular* capabilities of the applicants, for though all men are constituted with the same general faculties, yet all do not possess them in equal degrees of strength, nor are the same particular faculties always predominant in different individuals; it is a matter of no small moment that the first decision on this subject should be the ultimate one, for though there are cases in which a young man who is educated for one profession succeeds well in another, yet it is much more frequently happens that the habits of thought and action which have been contracted with reference to one sphere of life are found materially to interfere with success in a different one.

If there are any schoolmasters with us this evening, I appeal to them to break down the snobbish attitude which sometimes exists towards the prospective entrants into industry as manual workers. One of the objects of my paper is to arouse the interest and obtain the co-operation of persons responsible for: (1) advising boys as to their most suitable field of employment; (2) obtaining positions for boys in engineering establishments; (3) the after-care of boys undergoing training in the engineering industry. Such persons will undoubtedly ask what can the industry offer to apprentices? and my reply is that for the intelligent youth in engineering to-day there are greater opportunities than ever, especially in the South of England, which is rapidly becoming the home of the light engineering trades.

It must be remembered that the engineering employers in the south will not be able in the future to recruit skilled craftsmen from the north, as the slump in marine engineering and shipbuilding has curtailed the training of apprentices. Taking shipbuilding as an example, from Lloyd's Register of Shipping Annual Report for the year ended June 30th, 1934, between 1930 and 1934 the amount of new tonnage completed fell from 1,758,610 tons to 350,430 tons. To obtain a true perspective of the position, this last figure should be compared with pre-war figures. In 1913-14 the new tonnage completed was 2,020,185 tons, or nearly six times greater than

in the shipping year just ended. Think, for a moment, what this means to the engineering industry as a whole; it means that the industry has lost for a long time one of its finest training grounds for skilled craftsmen, and other sections of the industry must step into the breach and return in some measure the good work done by marine engineers and shipbuilders in the past, so that they will, when trade returns to them, be able to recruit some skilled craftsmen from districts and sections of the industry which have not been so badly hit by the trade depression.

It is not my intention to recommend any special scheme of apprenticeship training, as apprenticeship training schemes must vary from shop to shop, according to the nature of the product, the plan of the works, and the methods employed by the individual managements

Recruitment

Some firms obtain their apprentices by entrance examination; some by an official with special knowledge, whilst others leave it to the foremen. Care must be taken in the recruitment of apprentices, as from some of these young men the industry must expect to obtain new ideas and fresh vitality which is so essential if it is to compete successfully for the markets of the world.

We all know the type of boy who is continually asking why things happen, what makes the wheels go round, and numerous other questions which we sometimes tire of answering. Such a boy has the inquiring mind; if he is keen and intelligent in his inquiries and persistent in his desire for exact explanation, it is a distinct engineering symptom. Such a boy never sees a machine without analysing its parts, tracing their interactions back to the original motive cause, until he is perfectly familiar with every detail; he will not tire till his instinct is satisfied and he has found out "how it works"; he has the desire to *analyse* inborn; it is for this reason that schoolmasters and employers should realise the importance of accurate school-leaving reports and facilities should be provided by employers for visits of schoolmasters and boys to their works.

The psychologist has not yet progressed to the point where tests will do more than suggest in a broad way the fitness of young men for specific occupations. The physician, the lawyer, and the engineer can all utilise many of the same mental qualifications. Each may have mathematical ability, but the engineer *must* possess it; each may be scientific in his tastes, but the engineer should be distinctly so.

The author is of the opinion that the most satisfactory method of recruitment is to co-operate with the various committees appointed by the Ministry of Labour and the Board of Education;

such committees are always willing to help and the employer is given every assistance to help him obtain the best youths for his work.

While there is much to be said for some of the methods of recruitment used by employers in the past, it must be realised that in the interests of our industry, serious attention should be given to recruiting the labour best suited to it, and in a number of cases past practice should be discarded. The author favours selection by examination because it is essential that the prospective apprentice should have received a good general education such as will enable him to undertake with profit the course of technical and general education included in the apprenticeship training.

It is essential to discover the best qualities and abilities of applicants for apprenticeship and therefore the job of selecting suitable candidates for apprenticeship should not be given to an inexperienced person ; the person responsible for this work should know accurately the demands of each job in the works and he should be able to estimate the various qualities of each applicant for apprenticeship in order to obviate " misfits " as far as possible. Most engineering employers recruit juvenile male labour from elementary, junior technical, central, and secondary schools. As most of the boys educated at elementary schools leave at fourteen, for the purpose of starting work, the schoolmasters realise that it is far better for such boys to enter industry as manual workers rather than on the clerical side, especially when it is not possible to give to such boys a clerical training which will fit them for a definite career, and therefore it is found that in a large number of districts engineering employers at the end of the school terms are inundated with applications for employment ; in such districts there should be close co-operation between the schools and employers.

The junior technical school is fundamentally a vocational school, that is to say, the pupil at the moment of entering the school regards himself as definitely committed to a future vocation. The schools prepare their pupils for occupations which generally require entrants at about sixteen years of age ; usually such schools provide a large proportion of apprentices and learners to engineering.

The secondary schools, in the opinion of the author, are not at present supplying sufficient youths for employment in the engineering industry at an age suitable to engineering employers, and as a large number of boys from such schools are eminently suitable by their achievements and character to be leaders of others, it is unfortunate that closer contact is not provided in some districts between engineering employers and the " placing " machinery provided by the Ministry of Labour Public Secondary Schools Headmasters Committee. The author has for a number of years

co-operated with this committee with very satisfactory results and suggests that employers should consider the secondary schools as a fruitful source of supply of candidates for apprenticeship.

Central schools as established in some towns give a good general education and though they have a bias in the direction of vocational work, they make no attempt to train pupils for any specific trade, they are concerned mainly with the broad aspects of the training for a commercial or technical career.

In general, boys are recruited for four courses of training in the industry:—

(*a*) *Full Engineering Course* (various departments, including laboratory).—Youths recruited for this course are over sixteen, and are usually drawn from public or secondary schools, universities, and technical colleges. This course absorbs the smallest percentage of youths employed in the industry and as they undergo a period of training for the higher supervisory posts, I do not propose to deal with this course in the present Paper.

(*b*) *Trade Apprenticeship Course.*—This course is usually offered to boys from (1) elementary schools; (2) central schools; (3) junior technical schools; (4) secondary schools. The age of entry is generally from fourteen to seventeen years of age, the boys are required to train for craftsmanship in the basic crafts mainly consisting of blacksmiths, boilermakers, coppersmiths, fitters, millwrights, moulders, patternmakers, sheet metal workers, toolmakers, turners, and skilled machinists. This course may be either in accordance with written agreement or oral arrangement.

(*c*) *Drawing Office Course.*—The author refers to this course because of its close connection with the previous one; provision being made for workshop training and the certainty of some of the ex-apprentices deciding to remain in the workshop. Some of the large engineering firms have a drawing office course for training young men to become draughtsmen; such firms engage boys usually from junior technical and secondary schools for instruction in the works and the drawing office; they are generally recruited up to seventeen years of age and although the ultimate aim of this course is to equip young men for positions as engineering draughtsmen, there is always a possibility of those showing special aptitude eventually being transferred or obtaining positions on the production side of engineering.

(*d*) *Learners.*—We are living in an age of specialists and, with the continual improvement in methods of production in the engineering industry and the increasing sub-division of processes, there has emerged a tendency to substitute for the stricter forms of apprenticeship a less rigid form of industrial training, which we will call learnership.

Learners are recruited from the same source as trade apprentices ; the youths are generally engaged on machine and hand processes, and they progress without any obligation on the part of the employer to guarantee a period of employment or specialised training. In such circumstances, the youth takes his chance of promotion according to vacancies arising, and his suitability to fill such vacancy ; some employers give to selected learners at the end of their period of employment a certificate (see Appendix A) to serve the purpose of an endorsed indenture or service agreement usually supplied to a craft apprentice at the termination of his apprenticeship.

The author is of the opinion that the adoption of such a scheme for up-grading workpeople from lower class work to work which will eventually lead to craftsmanship is sound, and will not only assist in overcoming the shortage of craftsmen, but will offer a brighter outlook on life to the person who has not had the opportunity of a pre-arranged course of training.

Training in the Works.

Every effort should be made by employers to make the training of apprentices in the works as systematic as possible ; on this point the author suggests that where a number of engineering firms are situated within a reasonable distance of each other, they should establish a " clearing house " for learners and apprentices for the purpose of assisting youths, who are discharged or suspended, to obtain continuity of training ; if this is done in conjunction with the use of leaving certificates on which is entered the departments and class of work the youth has been engaged on, I am sure that it will help to retain some of the youths in the engineering industry who would, in the ordinary way, migrate from it about the age of eighteen. The provision of such a "clearing house" by sections of industry, or in districts, where youths who had received a certain amount of training would be registered and put in touch with suitable openings, should be seriously considered, as we must realise that our industry is expected to solve, and should be capable of solving, this important question of providing suitable men to maintain its high standard of craftsmanship.

If our industry requires a first-class product it must have first-class brains on the job. Very often the skilled craftsman is called upon to see a thing before it exists. Inventive ability is based on ingenuity, and while ingenuity is a natural gift, there is no doubt that the man who possesses a sound knowledge of workshop practice is able to think more quickly of remedies for difficulties, improvements, necessary changes suddenly imposed by changes in conditions, than a man who has not had a good practical training in craftsmanship in the workshops.

Generally speaking, youths employed in accordance with the trade apprenticeship course may be considered the foundation upon which is built the production of engineering commodities by those employed in the learner class, and as such commodities require to be standardised and turned out in large quantities special processes are evolved which require more development and larger employment of the learner class. It is the usual practice for youths in the trade apprenticeship class to obtain their training by working with and under the supervision of craftsmen. Some firms have a school or bay in the works to which is allocated a number of apprentices under the guidance of either a foreman or a chargehand ; in such cases it is generally for training youths who have paid a premium or the firm has a large number of apprentices which justifies it having a special department for their training ; sometimes this course is adopted because the firm considers it is the right policy to keep apprentices away from influences which may not be beneficial to them. The machinist apprentices are sometimes permitted to spend part of their training period assisting the machine tool setters in the production shops.

The workshop should be regarded as the place where the apprentice is taught how to acquire manipulative skill and practical knowledge of his work. It is essential for the craftsman to have workshop training ; if we look to the professional requirements of any of the recognised engineering institutions we shall find that, before any person can become a member, such person must in addition to having passed the examination, or having been exempt therefrom, have served a reasonable apprenticeship and must have been regularly trained as an engineer and be able to prove as a result of technical achievement and works' experience that he has reached a position of responsibility in the industry, and although we are at present concerned primarily with the training of craftsmen, we must bear in mind that it is from craftsmen that we obtain a large number of men to fill executive positions.

In the learner class most of the work consists of hand and machine processes in the various types of production work. Much of this work in the higher grades of processes can only be acquired by knowledge and skill of a specialised order and the work provides equally remunerative and important occupations to those of the craftsman class. It also provides the trade employment for those who, either from want of opportunity or inclination, do not become indentured apprentices to the basic crafts. The engineering industry continues to develop new trends as regards both requirements and training. Large numbers of youths not apprenticed are learning skilled work and will eventually take their place in skilled categories in the same way as apprentices.

It is well known that there is a responsibility and expense entailed in the employment of apprentices under agreement and an engineering employer naturally tends to limit the number employed to what he estimates will be sufficient to meet his own requirements. While this is an important factor in itself, it has a direct bearing on the possibilities of advancement within the engineering industry as such. In times of normal industrial expansion as a whole the engineering employer losing his skilled employees to other industries finds that he has not sufficient youths in training to meet his own requirements and takes the necessary steps to meet the difficulty, bearing in mind that the period of training for such youths under agreement is usually not less than five years. The employer naturally then turns to the learners who, while not having been afforded the opportunity to become indentured, have had certain experience in the learner class. If he does not employ the learner class in his own establishment there may be a youth seeking employment who has been released from some other establishment where the nature of the product requires such class to be employed—it is in such cases the "clearing house" previously referred to would function. According to the value of the experience obtained by such youth (both in theory and practice) the employer may make a rebate on the full time period usually applicable to regular apprenticeship and here is the opportunity for the boy who originally wanted to be apprenticed to obtain a belated apprenticeship in the trade apprenticeship class. When selecting a youth of this class the employer considers the time spent in the works, the processes engaged upon and his conduct, together with the result of his technical class work; these have a considerable bearing on his chance of selection for the vacancy and for this reason the youth entering the industry without a guaranteed period of training should realise, if he wishes to seize available opportunities for progress, that it is essential for him to obtain good progress reports (see Appendix B), and to attend appropriate classes, as it is for the apprentice under agreement.

It is to be hoped that the system of providing progress reports will become more universally adopted as the reports are of special value to those who are dealing with the problem of careers for the very large proportion of youths who, while unable in some cases through lack of opportunities, or being too old on entering the engineering industry to become indentured apprentices, are required in progressive occupations in the industry

From the first consideration of the three classes—full engineering course, trade apprenticeship course, and learners' course, the impression might be gained from the previous statement that it is only to the full engineering and trade apprenticeship classes that facilities are available for a course of training for an engineering

career. It has been explained that, provided the right link is established, a youth commencing his career in a limited sphere in the learner class can step into a vacancy occurring in the engineering and trade apprenticeship class; it must also be realised that many of the processes performed in the learner class provide occupations of a specialised order. Such processes are in a constant stage of evolution according to the advancement in science and invention and the varying requirements of civilisation.

According to the class of production carried on by the establishments, it will be found that there are many in which periods of training are provided, in some cases to the extent required for apprenticeship, and such establishments not only require the process specialist but others in supervisory capacities.

It is remarkable what can be accomplished with ordinary abilities when right desire is coupled with determination and diligence. So-called drudgery and seeming disappointment are often forms of discipline leading ultimately to success; many engineers have succeeded in life by patience, resolution and industry, rather than by extraordinary talent. Cheerful work is a mental and physical tonic; the spirit in which our work is done largely determines the quality of the results. Apprentices should be taught to face up to every situation by vigorous and enthusiastic application of their best powers, and therefore the person in charge of apprentices and learners should be a constant inspiration to them, for it is at an early age apprentices should realise that the qualities and abilities essential to supreme undertakings are developed first in small things.

Give the apprentice encouragement and interest in his work, let him know what he is making, how it will work, why a certain method of manufacture is followed and invite him to suggest alternative means of producing his work. What matters is not so much what we tell our apprentices but what we do towards helping them to discover things for themselves; they should be encouraged to develop independent thought, which is a necessary trait in the make-up of every successful man.

Theoretical Training.

It is not my intention to outline a course of technical instruction, as this is a subject for a paper of its own. I want to emphasise the need for technical education. The workshop training should be supplemented by instruction in technical subjects, so that youths can learn why certain methods are applied in given circumstances.

Engineering education is a continuous process, it does not make engineers but it offers to those of good intellect a preparation in fundamental subjects of study, a survey of the fields of engineering and mental discipline in the processes of analysts used by engineers. Education is not mere book-learning but the culture of the mind,

it is knowing the most useful things and doing them, it does not end after school but continues through life. Education is the harmonious development of all the faculties and the duty of we who are placing and training young men in the engineering industry is to see that they are given examples from which to gain inspiration; it is our charge to make something of them, to develop their powers and abilities for worthy use. Knowledge, efficiency, concentration, thoroughness, and similar acquisitions require long study and practice. The only powers which which can be brought into use at a critical time are those which have been developed, consciously or unconsciously, in advance of their being needed. No amount of brilliant and clever argument will enable the engineer to ignore the simplest law of physics and mathematics; facts must always be faced; materials of construction must not be used for purposes for which they are not intended; every machine must be tested and passed as efficient; analysis must take the place of guesswork; tradition must give way to absolute knowledge. A clever lawyer may be able by juggling words to persuade his listeners that two and two make five; a physician can convince a healthy person that he is ill; the engineer, however, whose figures are juggled, whose materials are not perfect, whose work is shoddy, must expect a day of reckoning; the machine fails and he pays the penalty.

In the past it has been the practice of technical colleges, schools, and institutions to cater chiefly for the design side of engineering, but during the last few years provision has been made in a large number of such establishments for teaching workshop science and processes, and the number of such establishments is increasing year by year. It is very satisfactory to note that there is now a strong desire to plan courses for youths engaged in workshop processes.

The Advisory Committee appointed by our Institution to the City and Guilds of London Institute, has drawn up syllabuses for a Grouped Course of part-time instruction in Machinists', Turners', and Fitters' Work. It will be seen therefore that our Institution, in conjunction with the Board of Education and with approved technical colleges and institutes, is endeavouring to secure the training of craftsmen in the most up-to-date and efficient manner.

Many firms, appreciating the importance of technical training for some of the occupations in the industry, provide special facilities for youths during their training to attend day or evening classes at appropriate institutions. Some firms offer prizes in order to encourage youths to become efficient in their studies, the prizes are generally awarded to students who obtain a satisfactory report from the principal of the institute, and take the form of books or instruments, in some cases a sum of money, usually equivalent to the fee for the session, is given. In addition to the immediate value of the prize to the student, it brings his attainments to the

notice of his employer and in that way improves his chance for promotion when a vacancy arises, as progress at technical classes is usually taken into account in determining whether promotion is justified; by making such awards for merit, an element of competition is introduced amongst the students, which results in a higher degree of efficiency all round, for it is essential to have competition with all its exacting, though vitalising factors, the chief object being to keep a high standard of technical education.

Apprentices should not be allowed to neglect their technical studies during the early years of their training. There is no post of duty, whether in engineering or other work, which can be successfully occupied by an individual who takes little or no interest in it; the duties may be very light, it may require a small portion of time and degree of intelligence to discharge them, but if there is no interest taken in them, light as they are, they will be almost sure to be imperfectly performed.

It is the opinion of some employers that the provision of technical classes for youths during the day obviates one of the inherent disadvantages of evening classes, namely, that after a day's work a youth cannot be in the most receptive condition for the study of difficult theoretical subjects.

Apprentice Associations and Professional Institutions.

The author considers that whenever possible apprentices should be encouraged to join apprenticeship associations when such associations are formed for the purpose of reading papers on subjects connected with engineering, and also at the earliest moment to qualify for membership of a professional institution.

With almost any vocation there should be connected a habit of attending useful lectures and debates which keep the faculties in healthful exercise, and in a constant course of improvement, for it must be remembered that the search for improvement is always active and that the education of an engineer is never complete.

There is a danger that a young man who is allowed to grow up in a great measure uncontrolled, will form a habit of idleness during the time he is away from work. You will find, with few exceptions, that young men who are allowed to do just as they please show themselves disposed to do very little, at least little to any good purpose, and the consequence is that in a short time they have a confirmed habit of idleness whenever they are away from the workshop and are not under control; the great mass of youthful minds will, in a measure, stagnate, certainly will not realise a legitimate development, unless they are quickened as well as guided by an outside influence. You may see this point strikingly illustrated in almost any engineering establishment; the patient, diligent, and successful youth is generally the one who is making the most of

his spare time by attending lectures and courses of instruction for the purpose of preparing himself to fill a responsible position in the future. Young men who think of nothing but their wages or their ease, instead of reaping the legitimate benefits of sound instruction, will contract bad habits, both intellectual and moral, and discover their error when it is too late.

Supervision of Apprentices.

In large establishments, with the creation of definite departments, there is a natural tendency for each department to regard itself as a business within a bigger business and so to work in watertight compartments. Yet there is very little routine in any business which does not affect more than one department and, therefore, for the purpose of carrying out any scheme of apprenticeship there must be perfect co-operation between the personnel of the departments concerned and, for this purpose, it is a good plan to appoint a person whose duty will be to ensure that apprentices receive a proper training. The person appointed should take an interest in the activities of the apprentices outside as well as inside the works ; he should encourage hobbies. However absorbing and pleasurable the regular occupation is to the apprentice, he should have a hobby to which he can turn for change and recuperation ; the brain and body weary of repeated effort and the absence of a hobby frequently accounts for his lack of interest in anything he is engaged upon except in so far as its success might be a help to keeping him alive. It is also important that during their period of training the health and general welfare of apprentices should receive careful and continuous supervision.

Foremen.

In dealing with the training of apprentices, the influence of foremen comes vividly to mind. It is essential for the engineering industry to have men in such positions who are able to train and influence the young charges in their care. It is for this reason the author is deviating for a short period to refer to some of the qualities needed by foremen.

The most important is leadership. Leadership should be based on the capacity to handle others ; it is one of the essential elements of the foreman's personality. A born leader has native force of character and a sense of discipline : he is master of himself at all times, has a magnetic influence and is sympathetic with his fellow men. Besides these fundamental traits, he must have learned something of human nature, human psychology, and the average human limitations. It is difficult to understand perfectly the handling of men unless one has been in their position. Men who begin life by commanding men but who have had no experience as subordinates

are likely to be severely handicapped in this respect, though they are born with many of the qualities which characterise leaders. For this reason, the author advocates a period of hard manual labour for persons who will eventually hold supervisory positions, in order to give them an opportunity to see and learn the conditions of labour, the attitude of employees toward each other and toward their employer, their limitations and the common mistakes which are made by the men who handle them. A man can easily learn these things from the bottom ; he can never perfectly learn them from the top.

In smaller establishments it is the duty of foremen to supervise the training of apprentices and in some works the life of the apprentices is separated from the life of the foreman almost as completely as are the lives of the flat fish and crabs in an aquarium. The two are closely mingled and yet do not communicate with one another.

Conclusion.

My address this evening has dealt chiefly with the recruitment and training of craftsmen, but it must be remembered that it is from this class of labour that we recruit a large proportion of men for executive positions and, therefore, it is our duty to ensure that we recruit the most promising material ; the author does not agree with persons who state that the engineering industry does not require boys for training in craftsmanship who are ambitious. Life without aim, ambition, work, and achievement, would be a monotonous treadmill. Indolence and idleness breed discontent and carelessness. The insistent demand in our industry is for men of initiative, self-confidence, resourcefulness, and efficiency ; reconstruction and reorganisation are always with us, and greater efficiency is demanded than ever before.

The people who are always disparaging the engineering industry are usually engaged in a sheltered industry, or are in a permanent post which gives them greater benefits than the engineering industry can provide, owing to the fact that it must rely to a large extent on orders obtained in face of keen competition.

It is impossible to overestimate the importance of the art and science of engineering as one of the powers which ministers to the material wealth and prosperity of this country. Engineering is pre-eminently a progressive science and the experience of to-day but helps to improve and extend the labour of to-morrow. We live in an age of high mechanical achievement and see on every side the perfect functioning of complex and delicate mechanisms developed and manufactured by craftsmen who are able to apply human thought and skill to materials in order to produce something of use to humanity.

Discussion.

MR. M. G. WOODS : I had an opportunity of meeting Mr. Ferguson prior to this lecture, and he mentioned that he did not think he subject was a particularly controversial one, but I think he has given us so much food for thought, and points for controversy that it is difficult to know where to start. In opening his lecture, he dealt with the question of Machines versus Labour. During the past fifteen to twenty years, this country has definitely had to face the fact that many industries have had to specialise. With that specialisation, as I see it, the question of recruitment of labour has become a very difficult problem. Departments are becoming much more watertight, and we ourselves find it extremely difficult to move employees from one department to another. Labour comes to us on the raw side, and we are put to considerable expense in training them to one job. I had occasion recently to ask for the cost of educating this class of labour in our own factory, and I must say it came as rather a rude shock to me to realise how much we had spent in twelve months in endeavouring to train this class of labour.

I would suggest the training of labour as Mr. Ferguson has outlined it is a function of the educational authorities. I feel the labour we get from the elementary schools—and I suggest it must be typical of the whole country—is extremely crude, and, while it might mean more taxation, I do suggest that education authorities should train this raw labour into something more efficient.

MR. FERGUSON : Regarding Machines versus Labour ; you could have two grades of training, one, say, for training as craftsmen and the other for producing process workers. That process worker I assume would be the class of worker you refer to. You produce a process worker who should in time be able to fill a gap which will ultimately lead to one of the higher positions, such as foreman.

On the question of recruitment of labour and departments becoming water-tight, and not wanting to transfer labour, that comes back to the same thing. You are training men on a certain process. You are giving them something, you are training them for something. Regarding your point that education authorities should train craftsmen as well as educate ; as an engineer I disagree. There are very few education authorities I should care to entrust with a youngster for producing an engineer or craftsman. Their equipment is not good and the men they have not competent, they cannot give the training an employer can give in the actual workshop atmosphere.

The tendency in education is to improve all through and industry is getting a better product. Engineering employers have it in their own hands to a certain extent to see they get the right material. You must set some form of elementary examination. By that means you are able to gauge the type of youth you are getting. It is better, to my mind, to get a good-class lad into your shops; it lends tone.

MR. WOODS: You referred to the question of technical colleges or schools being badly equipped. Whose fault is that? The primary function of a manufacturer is to manufacture goods, not to train labour in detail. In these days of specialisation labour should be trained by specialists, and if you equip such schools, and provide people to train them, you surely get a better result than by asking the manufacturers to undertake it.

MR. FERGUSON: The question is one on which I think you have to convince not only the engineering employers, but also the governors of such schools, that you want to produce an article from the practical point of view, and not only the theoretical.

I know of one company who had difficulty in obtaining competent setters for automatic machines, and has gone to the expense of equipping a technical institution with a battery of automatic machines and also sent round their men certain evenings in th week to teach youngsters to use these machines.

If you are going to carry that to the conclusion you have got to get these technical institutions equipped with up-to-date machinery. You have got to saddle industry and individuals with a large amount of money, which I very much doubt can be carried.

MR. WOODS: What about the Ministry of Labour Training Centres?

MR. FERGUSON: Some three or four weeks ago, I went to one of these, and was much impressed. The machine tools were removing metal, but if I had been in charge of that work, without the support of the Ministry of Labour, I should not have been able to compete with other firms.

The machine tools were not running at the correct speeds for one thing. In some places these centres are definitely fulfilling a need. I very much doubt whether in nine cases out of ten an employer could take a man direct from a training centre and put him on a machine tool or bench job, and expect to get from that man the same work he would get from a man employed at the firm for half the period. The Ministry of Labour do not expect these men to go from the training centres and work side by side with other men and produce the same amount. They cannot produce in six months men up to the standard produced in an engineering shop in the same period. As for making craftsmen in embryo they cannot do it.

MR. BRAZIER: I am a believer in the apprentice working with a highly skilled workman. I wonder what is the percentage of apprentices to-day who learnt by that means. It was mentioned we should take a selection of youths and put before them a number of questions. I am rather afraid about 90% of the boys we get could hardly read them. That is really due to the schools, and the night technical schools. When you ask boys to go back to school, they say, "What is the use? If we go there is nothing we can learn," because there is such a lack of interest in the technical school. That is due to the absurd plant, also the men in the technical schools.

In our works, I am sorry to say, we have offered to pay school fees and offered prizes if boys would only make 90% attendances, and obtain a first class pass. It is absolutely a failure.

Most of the boys, when you put this matter before them, say, "Why should we? I can get no higher than a workman; why should I learn these things?" Schoolmasters should instil into boys at an early age the importance of what they have to meet in the future. Most boys seem to lack vision and interest in the future. Most of them do not know what they want to be. I believe there should be some school after the age of say thirteen, where the boy would get some training, and settle in his mind what he would like to take up as future business, so as to make a man of him and a successful workman.

MR. FERGUSON: Obsolete plant. You can only get that rectified by close co-operation with the technical school or educational authorities. Does not that rather lead to the point I have been trying to emphasise, that is, the interest which a firm takes in its apprentices?

Referring to boys at the age of thirteen having a school to let them decide what trade they would like to go into, I am afraid that would rather be looking for trouble, because twice a month I attend the offices of the Ministry of Labour to interview youths from public and secondary schools, and some youngsters of twenty do not know what they want to be.

MR. BRAZIER: Is there any way in which production engineers can influence the technical schools to instal better plant, instead of waiting for some firm to give them some of their "junk"?

MR. FERGUSON: The question of co-operation with technical schools is really an important one. We in London have for years been trying to co-operate, and the tendency has been to co-operation with the educational authorities in this matter. I am on the management committee of one of the largest technical schools in London, and we endeavour to have the most up-to-date equipment.

It is up to you as employers to co-operate with educational authorities and tell them what you want. Tell them to provide

up-to-date machinery, so that you can send your youngsters there with a certain degree of feeling that they are going to do something which definitely benefits them in their future work. It is up to the employers or their representatives in that particular department to see that the technical education authorities do not provide obsolete equipment for training.

MR. AYTON: I have listened with great interest to Mr. Ferguson's lecture. I do not say I agree with him in every respect, but there are many things he has mentioned which certainly make us think. I do agree with him that the engineering industry does deserve stricture for some neglect of this question of properly training the apprentice.

Some of us are interested in export machinery and often have to send men out to erect it. If you are going to send a man out who has not received a comprehensive training and had a wide experience in that trade he may possibly be occasioned some difficulty which he is unable to face. That consideration supports the necessity for the thoroughness in the training of the trade apprentice which Mr. Ferguson has advocated.

I am no believer in paper examinations. There is too much of it in this country. I think you can select the right boy by talking to him far better than asking him to sit down and answer questions on paper. By questioning a boy you can bring out what you want to know about him and make a far better selection.

In connection with student apprentices there is this difficulty, some boys are inclined to be bored at the outset. That is a time when they do need particular attention, and a good foreman can do a lot in interesting a boy in his work, when he is inclined to think it is mere drudgery.

In regard to the qualifications of a foreman which Mr. Ferguson mentioned there is one particular qualification which I think requires emphasising. A good foreman should above all things seek to be fair. He should eschew favouritism. He should always seek to weigh the scales of justice fairly between the firm and the workman.

MR. FERGUSON: With regard to your men whom you send out to foreign countries they should not only go as your representatives, but be able to diagnose any failure in a particular machine.

With regard to the question of examinations, I am afraid we shall have to agree to differ on this point.

It is a fact that a very large number of engineering firms to-day do definitely have close co-operation not only with technical schools but secondary and elementary schools. Boys are trained in these schools on subjects which will definitely fit them to sit for examinations. Government departments, such as dockyards and arsenals, select youngsters at the age of thirteen, and put them into classes

and give them training in certain subjects, and at certain periods of the year they sit for entrance examinations. On the results of that examination they are entered for particular classes.

All depends on the result of that particular examination. They are sent to classes and each year there is an examination, and if these youngsters do not pass at a certain figure they are then taken off the school altogether. Should a boy pass at a certain figure and continue in the class, at the end of say the third year he is selected for training in the drawing office, estimating department, etc.

In my opinion, supported by years of experience, that is the only way in which you can select suitable youngsters to hold positions on your executive staff. Personally, I think also you must have some form of examination to discover whether a youngster is able to grasp the fundamental facts in order to become a skilled craftsman. You want to get these youngsters into your works for the purpose of having a reservoir of labour from which you can find your craftsmen.

You referred to the question of boys being bored. I can thoroughly endorse that, and I certainly agree that a foreman should be fair. Unfortunately in some works agitations have been brought about through foreman being unfair. He should always try and be patient, and will get more done in this way.

MR. BALDRY : Is there not a tendency at the present time for a boy who is taken on as a process worker to remain a process worker ? Even if he attends evening classes it is doubtful whether he will be given the opportunity of improving his position in the works' organisation. This being so, it is not to be expected that boys with technical training will embark on a career where the goal to be eventually reached is only that of a process worker. With regard to men who are sent abroad to perform installation or repair work it always appeared to me that such men were too useful in their own particular sphere to be advanced to the higher posts in the organisation.

The unskilled or semi-skilled machine minder may and often does, earn more money than the skilled man with the technical training who sets up and maintains the machines. This is one of the arguments often brought up when skill and technical training are discussed.

MR. FERGUSON : With regard to a worker not being given the opportunity to improve his position and the process worker getting into a rut, I suppose you could call it a rut if you wished to do so. You would also call attending an automatic getting into a rut, but a youngster stands an excellent chance of becoming a setter for automatic machines and he then earns more than the skilled mechanic. You have got to have skilled craftsmen to set these machines. One remedy to obviate the point you mention is a

system of payment by results, and setters and maintenance staff should participate in such a scheme.

With regard to the men being too useful to be promoted. I know what I would do. I would look round for another job. I am quite certain if an employer had a good man, and he knew it, he would not stand in his light.

As to boys not taking jobs because of lack of opportunities, it may be of interest to you to know that during the last year I have had through my hands nearly 600 boys, and I could only place just over 90 of these boys in appointments. From that you will see there is no lack at all so far as numbers coming forward. They were all good lads from secondary schools, but employers had not the work available to train them. It may not be the case in East Arglia, but certainly it is in London.

MR. DIGGLE: I have had one or two good jobs for boys recently, but they will not come. If you have a surplus of boys you are lucky. Regarding the Ministry of Labour training centres, I employed two young fellows recently, and they are shaping very well indeed, much better than bringing boys of fifteen or sixteen out of the street. With regard to the crude labour we get in, we train them for about two months, and then they go to the charge-hand and say "I am leaving to-night, because I am going to the C.W.S. for 2s. a week more." Another excuse is "Mother says the job is too dirty." What can you do? You have got to let them go. It is not because the charge-hands are unkind to them. We try to train them and give them instruction, but when they bring these excuses you cannot do much. I do not know how to tackle the problem. If you cannot get boys from the technical schools what are you going to do?

MR. FERGUSON: If you cannot get boys from the technical school, what definitely is the object of the school? With regard to wages, you can always point out to parents that there is a definite minimum rate in engineering which you are duty bound to pay. There is no minimum rate of wage in clerical work. In fact there are numbers of young people in clerical work who have sought to get jobs as engineering labourers because they cannot earn more than £2 a week in clerical work. You can also point out that if a boy attends evening classes, or part-time day classes where these exist, and reaches a certain standard, he would definitely be able to obtain a better job in the works or at another firm when he is twenty-one or so.

A youngster has a better chance to-day with many offices and banks becoming mechanised as there is work in producing these machines.

Ministry of Labour Training. I am glad to hear what you say.

It is up to employers to keep the centres up to scratch, and refuse to take men until they can manipulate a machine tool.

MR. NUTTALL : We have had some very frank criticisms, but the discussion seems to have centred largely round the unhappy state of affairs at Colchester. I do not propose to weary you with details of that state of affairs, only to say I believe there are quite certainly definite causes for it. The state of affairs can be remedied if all parties concerned really put their shoulders to the wheel. The education authorities will meet you if you go as a body, but if only one or two go, and are not prepared to give a definite undertaking as to how many boys will attend evening classes or day schools you cannnot blame the education authorities if they are limited in their expenditure.

Boys should be definitely encouraged in every way to go to evening classes and day schools. You have got to get someone from the Juvenile Advisory Committee or from the technical schools, to advise as to the best training suitable. It means a lot of work but if it is done properly you will get the right type of boys.

If you frequently get boys saying they want to be something in the clerical line, you have got to tackle the schoolmasters and juvenile employment officer for the area.

MR. FERGUSON : Co-operation with local employment committees is a thing which ought to be done. It is essential there should be co-operation with the education authorities and the Ministry of Labout to help them do their job. They have got to help you find your labour. They must realise that if we are to maintain a premier position, industry must have the raw material, i.e. adequate labour. You must definitely co-operate with them, and they will be only too pleased to co-operate with you. That is the only way you can get the right lads.

On the motion of Mr. Ayton, seconded by Mr. Rackham, a vote of thanks was adopted to Mr. Ferguson, who suitably replied.

APPENDIX.

Regulations and Syllabuses for the Examinations in Machinists', Turners', and Fitters' Work, City and Guilds of London Institute.

Note in regard to the Intermediate Examination in England and Wales.—When an examination in this subject at a stage corresponding to the Institute's Intermediate Examination is held by an Examining Union recognised by the Board of Education, a Local Education Authority which is a member of the Union will normally arrange that its students at that stage will take the corresponding examination of the Union. The City and Guilds of London Institute will accept for its Intermediate Examination a candidate or candidates from such a Local Education Authority only upon the specific request of the Chief Education Officer of the Authority for Higher Education, confirming that the Authority, having considered the matter, desires the City and Guilds of London Institute to accept the candidate or candidates for the Intermediate Examination.

The Advisory Committee of the Institution of Production Engineers in conjunction with the City and Guilds of London Institute has approved of the following scheme of syllabuses for a Grouped Course of part-time instruction in Machinists', Turners', and Fitters' Work. The course is arranged in two stages, Intermediate and Final, the minimum age on entry thereto being normally sixteen years. The work of the first stage should occupy a minimum of two years, and that of the second stage two additional years. At the end of the respective stages a student should be prepared to take the Intermediate and Final Examinations of the City and Guilds of London Institute.

A candidate who passes the Final Examination may claim exemption from the paper on Works Practice and Processes in the Graduateship examination of the Institution of Production Engineers.

The examinations, whether Intermediate or Final, to be held by the City and Guilds of London Institute will comprise *two question* papers, each of three hours' duration, to be answered in writing, or by drawing or sketches, the *first* paper being on Workshop Science and Technique, and the *second* on Drawing (including Sketching) and Calculations.

A candidate successful in either examination will receive the Institute's Certificate, which, in the case of a candidate who has

complied with the requirements of the regulation set forth below regarding attendance and progress at courses, will be countersigned on behalf of the Institution of Production Engineers by the President of the Institution for the time being.

In order to receive the Institute's Intermediate or Final Certificate countersigned by the President of the Institution of Production Engineers, a candidate must be certified* by a responsible officer of a Local Education Authority in Great Britain or Ireland, or of a Technical School or College, or of a Works School in these countries—such Works School being specifically approved for the purpose of this regulation by the City and Guilds of London Institute—by June 15th in the year of his examination to have attended satisfactorily during the two years prior thereto (*a*) a senior course in Drawing and Calculations extending over a minimum of fifty hours per annum, and (*b*) a course in the technical subject (where such course has been available) also extending over a minimum of fifty hours per annum, and to have made satisfactory progress in the allied (and technical) subjects during that time.

Syllabus.

INTERMEDIATE EXAMINATION.

(1) *Workshop Science and Technique.*
(2) *Drawing and Calculations.*

The following notes may assist the interpretation of the syllabuses.

The syllabus in Workshop Science and Technique does not constitute a programme of class work. It enumerates matters upon the majority of which, as a result of class work combined with industrial workshop experience, the candidate should be able to answer questions. It is anticipated that work done in the classroom and the instructional workshop (where available) will be designed to supplement daily industrial experience by intelligent consideration of typical operations and methods and their underlying principles, by giving opportunity for illustrative experimental work, and by the study of simple mechanics, heat, physical metallurgy, etc., in the light of workshop knowledge already possessed.

In so far as the syllabus is used as a guide to class work it will therefore be obvious that the matters touched upon in any section need not be taken consecutively, nor the sections themselves in the order given. Where (as is desirable) workshops for instruction are available the discussions and notes upon workshop science and technique will naturally be kept in step, as far as possible,

* Forms of Certificate may be obtained on application to the Department of Technology.

with the constructive or experimental work attempted, regardless of the order adopted in the examination syllabus.

In the course of instruction a selection of matter may, to a limited extent, be made to suit local needs. In the examination papers there will be a choice of questions in view of the diversity of training and experience of candidates. All candidates will, however, be expected to have a fair knowledge of bench work, lathe work, drilling, planing, and simple milling.

"Measurement and Gauging" is classed under Workshop Science and Technique for examination purposes. A substantial portion of the work under this heading will naturally be covered in the "Calculations" class.

Most workshop examples in mechanics occur in connection with machine tools and machining, and mechanics is therefore dealt with under that heading. This, of course, need not prevent independent class treatment if desired.

Many of the simpler points mentioned in connection with measurement, heat, mechanics, etc., will preferably have been covered in a preliminary course.

(1) *Workshop Science and Technique.*

Materials.

Metals and Alloys.—Composition and properties of the principal ferrous and non-ferrous metals; comparisons of the effects of temperature upon them, and of their density, strength, hardness, ductility—so far as these can be studied by workshop tests. Examples of simple manufacturing operations involving plastic deformation as illustrations of these properties. Currently accepted measures of hardness, strength, and toughness; and their interpretation.

Heat and Heat Treatment.—Heat, temperature, and temperature measurements, radiation, conduction, and convection. Processes of annealing, normalising, quenching, etc., and their effect on material. Examples of these processes for different grades of carbon steel, and their application to the preparation from the bar of a chisel or lathe tool. Work-hardening, and correction of its effects when harmful, with examples. Case-hardening.

Primary Forming Processes of Rough Parts.—Simple examples of primary forging processes such as sand-casting, forging and drop-forging, pressing and drawing, fabrication by welding. Examples should be chosen from simple parts in common use.

Machine Tools and Machining.

Principles of Machine Operations.—The copying and generating principles in the lathe and their extension to other machine tools; the slide rest and lead screw as universal components. General

principles embodied in the design, and governing the operation, of lathes, milling machines, planing, shaping and slotting machines, and drilling machines. Straightforward examples of work of each.

Methods of setting-up and holding work for single-piece production.

Conditions for accuracy: care of machines, correct adjustment of centres and slides, alignment, etc.; distortion of work. Importance of rigidity and methods of its attainment: rigid attachment of tools, care of Morse taper shanks and sockets, need and methods of clamping slides when not in motion, care of exposed machine slides to maintain well distributed bearing.

Lathe Work.—Turning on centres, chuck-work, face-plate work. Effect of tool height upon cutting angles and upon profile in taper work. Methods of taper-turning. Screw-cutting (see also syllabus for Drawing and Calculations).

Speeds and Feeds.—Elementary consideration (see also syllabus for Drawing and Calculations). Effect of variation in speeds and feeds upon (*a*) power absorbed, (*b*) temperature of tool tip (*c*) finish of work.

Shop Mechanics.—Elementary principles of mechanics applied in all cases to workshop instances. Force as producing stretching, bending, twisting, fracture. Force as tending to cause motion. Direction and magnitude of forces. Equilibrium; reaction to applied force. Tension, compression, torsion bending. The leverage (moment) of a force; the triangle of forces. Components of force at a tool point. Tension in belts. The driving couple applied to a shaft by means of a belt pulley or gearwheel. Friction—assisting clamping operations but impeding motion; influence of materials in contact; meaning of "co-efficient of friction." Force ratio or mechanical advantage in simple mechanisms. Work done by a force in overcoming resistance. Work input and output of mechanisms; efficiency.

Cutting Tools.

The cutting process as instanced in hand operations (chipping, filing, scraping), shearing, and machine cutting. Cutting tools for lathe, planer, shaper, etc. The purpose of clearance and rake in tools: the true value of these angles taking into account feed, depth of cut and tool profile. Roughing and finishing tools. Modification of tools in accordance with metal to be cut. Preparation of cutting tools from carbon and high-speed steels.

Methods of grinding tools; precautions to be taken to maintain accuracy and prevent damage.

Design and cutting action of drills, reamers, "D" bits, etc. Screw-cutting tools, taps, and dies.

Parallel milling cutters with straight or spiral teeth.

Fitting and Erecting.

Selection, use and care of chisels, files, and scrapers. Methods of scraping and bedding. Production of simple profile gauges. Keys and keyways. Drilling, tapping, stud and dowel fitting, during assembly.

Soldering, brazing, welding, and riveting. The use of the blow-pipe. Hot and cold bending of wrought-iron pipe. Screwing of pipes and jointing by socket, flange, running joint, etc.

Measurement and Gauging.

Measurements of length. Weight and weighing. Density and its determination.

The vernier and its application to the vernier caliper. The micrometer. Measurement by comparison with standards. The sine bar.

The use, care, and adjustment of "go" and "not go" gauges. Length, depth, wire, plug, and gap gauges, etc.

The production of flat surfaces. Use of surface plate and methods of checking same. Marking off, vee-blocks, surface gauge, etc. Tests of truth, concentricity, and roundness.

Auxiliaries to Standard Machine Tools.

Standard equipment such as chucks, machine vices, circular tables, dividing heads (spiral milling, etc., need not be considered at this stage).

Development of lathe by use of square tool post, hexagon turret, and multiple trips and dead stops.

Simple jigs and fixtures. Methods of locating work in jigs (*a*) for first, (*b*) for subsequent operations. Methods of securing jigs to machine tables.

Lubricants and Cooling Agents.

Lubrication of machine tool spindles, gears, slides, and centres: purpose, type of lubricant, and method, with special reference to points requiring direct attention of the operator.

Use of cutting oils and solutions to improve finish of work: type of lubricant and methods of application.

Use of solutions with special object of minimising rise of temperature of work and tool: selection of suitable solution and methods of application.

Safety Measures.

The need of commonsense precautions on the part of workers, and possible results of neglect to report apparently slight accidents.

A review and analysis of accident statistics as issued by H.M. Home Office and the causes and prevention of accidents recorded therein.

(2) *Drawing and Calculations.*

(*a*) DRAWING AND SKETCHING.

Checking the accuracy of the tee and set-squares.

The use of drawing instruments in construction of common geometrical figures including examples upon the circle and tangent.

Orthographic projection of simple solids with applications.

Freehand sketching. Perspective and projected views (with dimensions) of objects in common use in machine shops.

The making in accordance with B.E.S.A. conventions (dimensions, relation of views, etc.) of machine shop detail drawings of two simple related component parts with dimensions and working limits (such as a split coupling with centre register, adjustable tool-post, etc.) and of the related assembly drawing. Instructions and references on drawings to conform to good modern practice for issue to shops.

(*b*) CALCULATIONS.

The four rules of arithmetic; decimal and vulgar fractions: mutual conversion of the two types of fractions. Averages, ratios, square roots, the metric system—conversion between English and metric systems.

Calculations of areas, volumes, and weights. Use of symbols, "Guldinus" theorem and its application. Effect of errors in direct measurement upon calculated weights, etc. Percentage accuracy. Calculations relating to surface speeds of rotating bodies and their application to cutting speeds of work. Pulley and belt speeds, cone pulley drives, gear-trains for screw-cutting, gear cutting, worm gears, etc.

Geometry of the alignment of machine tools in common use.

Geometry and calculations relating to setting out templates and jig plates and marking off castings and the use of tables of trigonometrical ratios as applied to this.

The use of logarithms and slide-rule.

Graphic work as applied to solution of equations and other problems. Plotting of statistics, etc.

Final Examination.

(1) *Workshop Science and Technique.*
(2) *Drawing and Calculations.*

The syllabus under (1) covers an extremely wide field, and it is even more necessary than at the previous stage that class work should have as its object to supplement the widening practical knowledge of the candidate and to focus attention upon matters within his experience which need study, explanation, and the application of geometry, the science of materials, mechanics, and the beginnings of the art of organisation. Unless explicitly stated otherwise, a qualitative rather than a quantitative treatment of mechanics, science, etc., is desired. As in the previous stage there will be some choice among such of the questions on the paper as deal with specialised processes.

(1) *Workshop Science and Technique.*

The Final Examination may include more advanced questions in the subjects of the Intermediate Syllabus, and the candidates will also be required to show a knowledge of the following subjects:

Materials.

Metals and Alloys.—Composition and properties of the principal special steels and special non-ferrous alloys encountered in the machine shop either as tools or materials for production. Impact tests; scleroscope, ball, and diamond, hardness tests; work-hardening test. Effect of high temperature on strength.

Heat and Heat Treatment.—Methods of measuring furnace temperatures. Heat treatment of special alloy-steels, high-speed tool steels, alloy cutting tools and of large forgings and castings.

Primary Forming Processes.—Methods for quantity production. Special foundry methods such as die-casting. Hot-pressing and extruding of non-ferrous metals. Hot-pressing and flanging of steel plates; more advanced treatment of welding.

Machine Tools and Machining.

Principles of Machine Operations.—General principles embodied in the design and construction of capstan and turret lathes, universal milling machines, thread milling machines, boring machines, multiple drilling machines, broaching machines, and gear-cutting machines. Operations carried out by these machines, and methods of holding work. The essential care of such machines for the production of accurate work. Tool-setting, importance and methods of rigid attachment of tools, with reference to effect upon accuracy

and finish of work produced. Adjustment of tools in accordance with material to be cut.

Speeds and Feeds.—Consideration of speeds and feeds for the preceding machines and their effect on the power absorbed, temperature of tool, and finish of component. Speeds and feeds used in machining high-tensile steels, etc. Increase in speeds made possible by the use of special and high-speed cutting alloys.

Heavy Work.—Planing, boring, facing, and turning operations upon large parts, the handling of heavy pieces, and the detailed processes in setting-up.

Shop Mechanics.—Constant and varying velocity. Forces called into play when velocity varies; centrifugal forces. Balancing of work on face-plate. Power. Work input, friction losses and work output for steadily moving machine; work stored in planer tables, rapidly rotating fly-wheels—e.g., of press or punching machines. Inertia, reversing of slotter rams, etc. Impact, hammers of all kinds. Spreading of metal under blows of various magnitudes.

Descriptive treatment of stresses in machine parts. Effect of the nature of these stresses on the design of the part.

Friction.—The use in belt, rope, and clutch drives. Ball and roller bearings.

Cutting Tools.

Analysis of form and cutting action, and tool-room operations in connection with lathe and similar cutting tools (including form tools), twist drills, reamers, broaches, plain and formed milling cutters, taps, dies, and chasers.

Construction, action, and use of opening dies and collapsing taps. Boring bars. Chip clearance in cutting tools. Use of special tool steels and alloys for cutting tools. Use of case-hardening steel for tools. Selection of type of steel in accordance with work to be done. Testing the hardness of tools.

Fitting and Erecting.

The mechanics of lifting tackle—e.g., blocks, jacks, rigging, slings, lashings, knots, bends, and hitches. The erection of a derrick. Strength and care of slings, chains, and wire ropes, and removal of fatigue. Foundation bolts, templates, etc. Methods of securing alignment and levels. Shrinking and forcing on.

Measurement and Gauging.

Manufacturing tolerances. Machine shop and inspectors' gauges. Length standards (historical). Usable standards. Measurement by comparison with standards. Horizontal and vertical comparators. Measuring machines—uses of the light lever in measuring. Use and checking of Johannsen and similar slips.

Types of measuring and gauging intruments in common use. Uses of the spirit level. Methods of gauging tapers, vees, dovetails, and special forms. Forms of screw-thread; analysis of form into its elements—meaning of pitch, effective diameter, etc. Measurement of screwed work and screwing tools (external and internal) by direct and projection methods. Relation between pitch error and effective diameter.

Measurement of gear teeth. Measuring the divide of splined shafts.

Tooling, Tool-room Work, Jigs, Fixtures, etc.

The tool-room use of the universal milling machine, universal cutter grinder, relieving lathe, etc. The universal dividing head. Compound indexing.

The roller-steady box. Example of a typical lay-out for simple job employing six turret faces, to illustrate the principles and uses of a capstan lathe.

Simple press tools for blanking, bending, drawing.

Jigs and Fixtures.

Methods of holding work. Problems of distortion—(a) through clamping forces, (b) through relief of stress as a result of machining.

Checking the accuracy of jigs and fixtures. Effect of design and material on maintenance of accuracy.

Rapid loading jigs for quantity production. Economic aspect of jigging and tooling in reference to quantity and value of parts to be produced.

Standardisation of clamps, bushes, registers, etc.

Sequence and Planning.

The work in this section should be limited to the factors governing the sequence of operations upon work of ordinary difficulty calling for a relatively small number of machine processes.

Differentiation between piece, batch, and quantity production; and effect upon methods of machining. Relative advantage of group and line production. Time setting and calculation and recording machine capacity against output programme.

Division of machining into operations, and factors governing selection of first or datum operations. The need for roughing and finishing operations with intermediate heat treatment to remove internal stresses. Removal of distortion occurring during machining and effect of this on sequence of operations.

The determination of necessary stages of process inspection to avoid scrap. Simple estimates of quantities of material required, machining margins, percentage of scrap for given quantities of work.

Grinding.

Dry and wet grinding. Types of machines in common use. Types of grinding wheels with reference to grits, grades, and bonding. Selection of wheel for work to be done. Safe wheel speeds. Balancing of wheels.

Effect of arc of contact of wheel on temperature rise, with reference to creation of hardened zones and surface cracks in alloy steels and safeguards against same.

Plain internal and surface grinding. Tooth grinding of gears. Screw thread grinding. Grinding of non-ferrous materials. Honing and lapping.

Lubrication, Lubricants, and Cooling Agents.

Simple explanation of the principles of lubrication ; oil films and bearing clearances.

Cutting lubricants and coolants, their specific properties, and the factors governing their selection for typical jobs.

Safety Measures.

Types of guards for machines such as direct mechanical guard, remote or interlocking control, dual hand operation, etc., and various safety devices.

(2) *Drawing and Calculations.*

(*a*) DRAWING.

In view of the varying industrial experience and training of candidates two *alternative* principal questions in sketching and drawing will be set, while some choice will be allowed among subsidiary questions.

One principal question will provide for the candidate dimensioned drawings with full particulars of two or more quite simple articles of production. For *one* of these he will be required to prepare sketches (freehand or not as he prefers) in sufficient detail to explain clearly to a tool draughtsman his suggestions for press tools, turret tools, milling or drilling jigs or fixtures, as the case may be, and gauges for economical production of the part. The sketches, though not finished drawings, should follow drawing office conventions as regards arrangement of views, etc., should be fairly completely dimensioned, and should specify materials and finish.

The alternative principal drawing question will meet the case of the candidate whose shop experience has been on large or general work. It will test the candidate's power of interpretation of a fairly complex drawing, but will at the same time have relation to the methods of setting-up and machining an important casting or forging.

The following should also have been covered.

Drawing of position—and velocity—time graphs for a quick return motion and a simple cam mechanism occurring in a machine tool.

Practical geometry and trigonometry applied to problems of gauging, to more difficult marking off and machining problems, to erection and alignment and to testing the accuracy of machine tools.

(*b*) CALCULATIONS.

More difficult examples upon mensuration, quantities of material, value of scrap, machining time, wage calculations, etc. Graphs of shop statistics, progress, etc. Wheel trains for fractional pitches. Calculations arising from the varied uses of the universal dividing head.

Full Technological Certificate.— A Full Technological Certificate is awarded to a candidate fulfilling the conditions of Regulation 37.

The Certificate awarded to a candidate in the Final Examination who fulfills the requisite special conditions as to attendance and progress at courses set forth in the preamble will be a Full Technological Certificate.

Full Technological Certificates will be countersigned by the President for the time being on behalf of the Institution of Production Engineers.

Text-books and Works of Reference.—See Appendix A, Subject 49 C.

Prizes.—For particulars of the prizes offered by the Armourers and Brasiers' Company upon the results of the Final Examination, see Appendix B.

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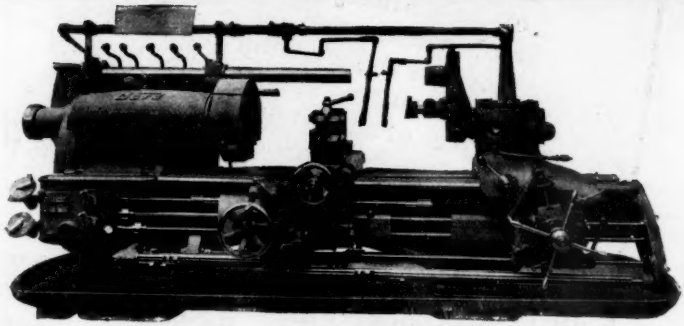

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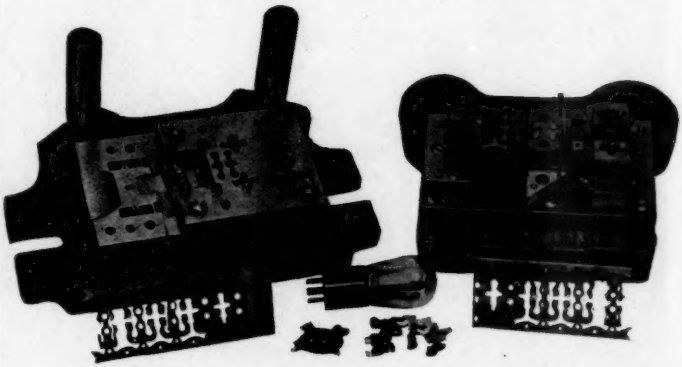

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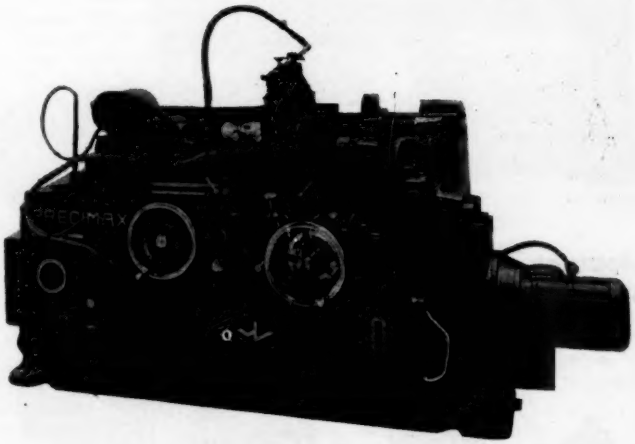

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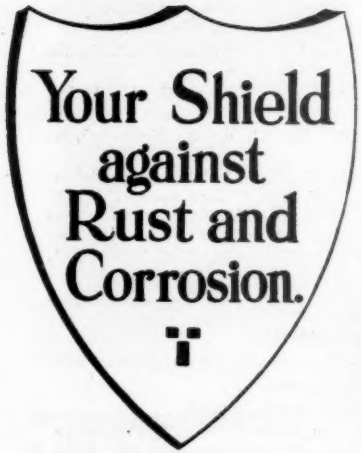
PROTEXON



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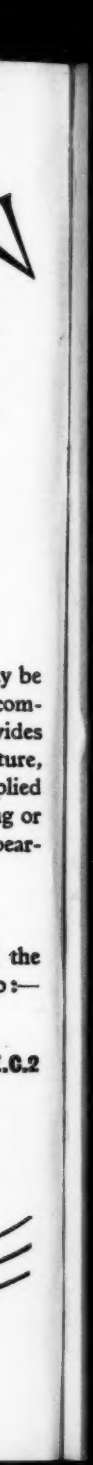
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